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Hawaii-Hyperspectral Airborne Remote Environmental Sensing (HIHARES'09) Experiment

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14. ABSTRACT This report describes data collected during one of a series of NRL remote sensing and calibration and validation (Cal/Val) campaigns, undertaken to develop models of coastal environments for use in rapidly processing hyperspectral imagery (HSI) and generating shallow water bathymetric charts and trafficability maps. This report describes data collected during the Hawaii-Hyperspectral Airborne Remote Environmental Sensing (HIHARES'09) experiment conducted at Marine Corps Base Hawaii and Marine Corps Training Area—Bellows from January 21 to February 6, 2009. Airborne HSI from the HyMap™ sensor was collected over these sites and adjacent areas in conjunction with NRL Cal/Val activities that sampled spectral and geotechnical data for the development and validation of trafficability, shallow water bathymetry, and vegetation maps appropriate to this coralline coast type. Trafficability maps and shallow water bathymetry maps were derived for HIHARES'09 study sites preparatory to an experiment at Shoalwater Bay, Australia, to support the development of imagery-derived trafficability maps for exercise TALISMAN SABER '09.					
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ABBREVIATIONS AND ACRONYMS

AFRL	Air Force Research Laboratory
ARTEMIS	Advanced Responsive Tactically Effective Military Imaging Spectrometer
ASD	Analytical Spectral Devices
Cal/Val	Calibration/Validation
CBR	California Bearing Ratio
DCP	Dynamic Cone Penetrometer
ESRI	Environmental Systems Research Institute
GIS	Geographic Information System
GPS	Global Positioning System
GSD	Ground Sample Distance
HIHARES'09	Hawaii-Hyperspectral Airborne Remote Environmental Sensing
HSI	Hyperspectral Imagery
HyMap	Hyperspectral Mapper
in	inches
JPEG	Joint Photographic Experts Group
km	kilometer
LPA	Littoral Penetration Area
LPP	Littoral Penetration Point
LPS	Littoral Penetration Site
LWD	Light Weight Deflectometer
m	meter
μm	micrometers
MARFORPAC	Marine Corps Forces Pacific
MCBH	Marine Corps Base Hawaii
MCIA	Marine Corps Intelligence Activity
MCTAB	Marine Corps Training Area–Bellows
MEC	MARFORPAC Experimentation Center
MEU	Marine Expeditionary Unit
NGA	National Geospatial Intelligence Agency
NRL	Naval Research Laboratory
nm	nautical miles
ONR	Office of Naval Research
PACOM	Pacific Command
TACSAT	Tactical Satellite
TS'09	Exercise TALISMAN SABER '09

EXECUTIVE SUMMARY

The Naval Research Laboratory in collaboration with a number of other institutions (e.g., Office of Naval Research, National Geospatial-Intelligence Agency, U.S. Geological Survey, National Oceanic and Atmospheric Administration, University of Virginia, Purdue University, University of Hawaii, Marine Information Resources Corporation, Technical Research Associates, and the Nature Conservancy) has developed look up tables for estimating trafficability in littoral regions and the remote retrieval of bathymetry from hyperspectral imagery (HSI). Key instrumentation to collect necessary and sufficient data for analysis includes dynamic cone penetrometers, light weight deflectometers, sediment corers, field spectrometers, underwater spectrometers, and handheld sonar. To date this trafficability research has been conducted along the coastal lagoons found at Cape Charles, Virginia, along the Pearl River in Mississippi, and at Kaneohe Bay on Oahu, Hawaii.

The ability to rapidly model bearing strength and shallow water depths from HSI directly relates to correlations between spectra and factors such as dynamic modulus and soundings in very shallow water. In NRL's trafficability investigations, dynamic modulus is determined across the beach, fore-dune ridge, and into the hinterlands along a surveyed transect. Very shallow water depths are sensed in synchronization with the incoming and outgoing tide and depend on one of two possible near infrared water absorption feature. Dynamic modulus is a function of factors such as beach composition and soil moisture while the near-IR features correspond to a peak in the correlation with depth in the very shallow water regime. NRL has found that in very shallow water, reflectance depends primarily on water depth (water absorption) and bottom type, with suspended constituents playing a secondary role.

HIHARES'09 was a remote sensing campaign conducted at Marine Corps Base Hawaii and Marine Corps Training Area-Bellows in accordance with a science plan developed by Bachmann et al. (2009). Some of the important data and information include imagery, field spectra, dynamic modulus, California Bearing Ratio, and shallow water bathymetry. Data are archived in a geodatabase along with various visualization and analysis products. The final products are trafficability maps and shallow water bathymetric soundings. This campaign was in preparation for research being conducted at Shoalwater Bay in Australia to support the development of imagery derived trafficability maps for exercise TALISMAN SABER '09.

1.0 Introduction

This data report presents airborne hyperspectral imagery (HSI) and sea and ground truth observations made in Oahu, Hawaii during Winter 2009 as part of the Hawaii-Hyperspectral Airborne Remote Environmental Sensing (HIHARES'09) Experiment. Goals and planning for HIHARES'09 were defined in a science plan (see Bachmann et al., 2008). In review, HIHARES'09 was carried out to characterize bearing strength and shear of the foreshore in order to assess trafficability and to investigate the feasibility of extracting shallow water bathymetry from HSI. This data report highlights elements of the science plan and presents a description of the field program and instrumentation, an overview of original data through summary plots and statistics, spectra, and imagery. The objective behind this data report is to describe archived data and information as well as the HIHARES'09 geodatabase. Example summary plots and statistics will also facilitate browsing the geodatabase.

Numerous authors (Bachmann, Nichols et al., 2008; Bachmann, Montes, et al., 2008; Bachmann et al., 2009; Curcio and Petty, 1951; Mobley 1994; and Mobley et al., 2005) have discussed the use of HSI for the classification of coastal types and the estimation of shallow water depths. NRL's approach to coastal classification is an adaptation of Francis Shepard's work (see Nichols and Williams, 2008), where coastal subdivisions occur according to which specific agent, terrestrial or marine, has the greatest influence on coastal development. Coastal geodatabase development at NRL directly benefits the development of algorithms for processing HSI. Most importantly, the geodatabases facilitate the study of diverse coast types. Efforts are currently focused on developing accurate relationships between spectra and environmental factors such as bearing capacity or water depth in order to support military decision making. Operational organizations such as the Naval Oceanographic Office, Marine Corps Intelligence Activity, Marine Corps Forces Pacific, and U. S. Pacific Command have expressed interest in trafficability maps and shallow water bathymetry. HIHARES'09 results will therefore be adapted to support the Marine Corps Planning Process. Imagery derived products will aid intelligence personnel to report factors such as shallow water bathymetry and trafficability. This information will improve the manner in which amphibious planners determine the capability of vehicles to transit the beach and pass through beach exits.

Leading up to HIHARES'09 several white papers, proposals, professional military education and programmatic presentations were provided to various Navy and Marine Corps proponents regarding the Naval Research Laboratory's methodology and recent activities relevant to coastal characterization. Research activities in Hawaii will culminate during the execution phase of exercise TALISMAN SABER '09 (TS'09). The final brief for HIHARES'09 to MARFORPAC staff and selected others from the PACOM staff occurred on February 6, 2009 at Camp Smith.

2.0 Field Experiment

HIHARES'09 was carried out from January 21 to February 6, 2009 at Marine Corps Base Hawaii (MCBH) on Oahu and consisted of an airborne survey and the collection of ground and sea-truth data. The field Cal/Val team used laboratory space for sample processing at the MARFORPAC Experimentation Center Integration Facility in Bldg 1386. Personnel limitations such as not having scientific divers resulted in reduced data collection than what was originally described in the science plan.

The geography of Kaneohe Bay is provided in Figure 1. This area is well studied. Electronic data resources where complementary information for HIHARES'09 can be found is provided in Appendix A. Principal study sites aboard MCBH included data collection efforts at Pyramid Rock beach, Hale Koa beach, and the rifle range. Data were also collected at Marine Corps Training Area–Bellows (MCTAB), in Waikiki, and at UH Lyon Arboretum and Foster Botanical Gardens.

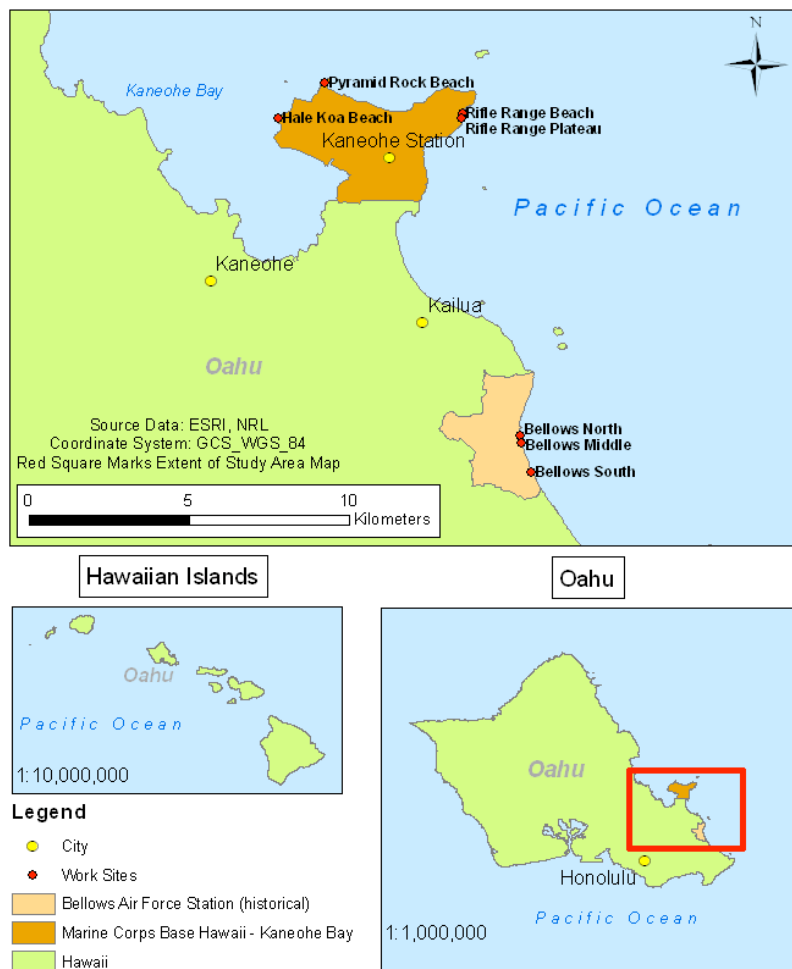


Figure 1. The geography of Kaneohe Bay and surrounding region. The work sites are marked with red dots. Relevant cities are designated with yellow dots.

2.1 Airborne Survey

HIHARES'09 was carried out using the HyMapTM airborne spectrometer and several CEROS funded sensors mounted on a Piper Navajo twin engine aircraft. HyMap stands for “hyperspectral mapper” and provides 128 bands across the reflective solar wavelength region of 0.45 – 2.5 μm with contiguous spectral coverage (except in the atmospheric water vapor bands) and bandwidths between 15 – 20 nm. The spectral configuration of the HyMap sensor is depicted in Table 1.

Table 1. Spectral configuration of HyMap. Each of the spectral modules contains 32 bands for a total of 128 spectral bands.

Module	Spectral Range	Bandwidth across module	Average spectral sampling interval
VIS	0.45 – 0.89 μm	15 – 16 nm	15 nm
NIR	0.89 – 1.35 μm	15 – 16 nm	15 nm
SWIR1	1.40 – 1.80 μm	15 – 16 nm	13 nm
SWIR2	1.95 – 2.48 μm	18 – 20 nm	17 nm

Additional details on the HyMap sensor may be accessed online at URL: <http://www.hyvista.com>.

Flight lines that are provided in Appendix B were planned so that adjacent strips overlap ensuring that complete ground cover was achieved over the MCBH study area. Flight lines were planned to cover the study boxes that are provided in Figure 2. Since these boxes

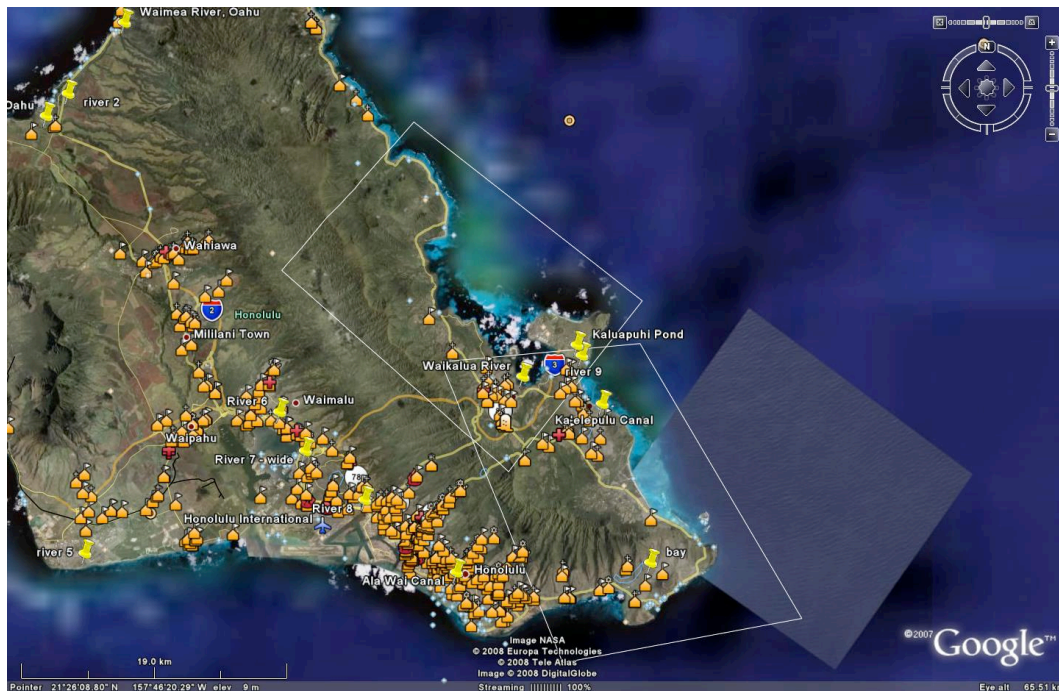


Figure 2. HIHARES'09 Study Boxes. This view of Oahu, illustrates the location of primary flight regions. The northern most box encompasses Kaneohe Bay, MCBH-Kaneohe Bay, and surrounding beaches and inland tropical forest regions. The southernmost box includes Bellows AFS.

include areas that are covered by water, data was only collected when solar zenith angles were between 30-60° in order to minimize glint. Imagery was also acquired near both low and higher tidal states since one objective involved verifying bathymetry retrievals in the very shallow water limit of the inter-tidal zone.

Each imagery strip was composed of successive scan lines acquired by the scanner along the flight line. The HyMapTM survey captured images of Oahu in narrow contiguous wavelength partitions or spectral bands, to create a data cube from which diagnostic spectra can be obtained from each pixel in the image.

Radiance values from each pixel were measured at many narrow, contiguous wavelength intervals. Such an image provides detailed spectral signatures for every pixel. These signatures often provide enough information to identify and quantify materials, even within a particular pixel. NRL employs the collected hyperspectral images to locate and quantify different types of vegetation, beach composition, soil moisture, and depths that are present within possible littoral penetration areas.

A complete listing of available imagery is provided in Appendix C.

2.2 Calibration/Validation Data

Primary instrumentation to collect necessary and sufficient data for analysis includes spectrometers, light weight deflectometers, and dynamic cone penetrometers. The spectrometers were used to collect field spectra in support of remote sensing image analysis. The light weight deflectometer (LWD) was used to impart a pulse by dropping a weight onto a spring mounted on top of a base plate, which simulated the response of the surface to vehicle traffic. The dynamic cone penetrometer (DCP) measured the kinetic energy required to push a probe through the soil. Real-time kinematic beach surveys were also conducted. The use of geotechnical instruments fostered the accurate characterization of MCBH's coarse-grained and sandy littoral environments. NRL found the MCBH littoral region was very different than previously studied coasts composed of plastic clays, combinations of clayey gravels and sands of lesser plasticity, and lean clays and silts.

2.3 Site Characterization

MCBH is an approximately 12 km² reservation on Mokapu Peninsula on the northeast side of the island of Oahu. The base is bounded by Kaneohe Bay, the Pacific Ocean, and Kailua Bay. Seagrass such as paddle weed (*Halophila ovalis*) was observed in the Hale Koa Beach/West field area. The offshore area at Pyramid Rock Beach is composed primarily of sand and exposed, barren basalt with limited coral coverage by small colonies of cauliflower coral (*Pocillopora meandrina*). The Expeditionary Assault landing site is within an area associated with a wide sand channel that extends several hundred yards offshore.

This study area can be best described as a coralline coast. In Kaneohe Bay, a narrow reef crest is located approximately 0.5 nm offshore. Aggregated coral heads are located on

the back reef, and isolated patch reefs occur on the reef flat shoreward of the back reef. Some of the common stony coral species within the Kaneohe Bay are provided in Table 2. In many locations, the seafloor tends to be composed of a flat limestone platform and brown algae such as *Distyopteris australis* can be found in the intertidal zone. Coral coverage seemed to range anywhere from 2.5 to 67.5 percent.

Table 2. Common corals found around Kaneohe Bay.

Scientific Name	Common Name	Description
<i>Cyphastrea ocellina</i>	ocellated coral	Small encrustation's or mushroom-shaped clumps; light reddish brown.
<i>Fungia scutaria</i>	Mushroom coral	Solitary coral on large (4-28 cm), free, elliptical plates; green to dark brown.
<i>Montipora verrucosa</i>	rice coral	Highly variable, encrusting and plate-like (shallow water) or branching (deep); dark-chocolate with white borders to beige or white.
<i>Pavona varians</i>	false brain coral	Encrusting globular masses; tan or tan-brown.
<i>Pocillopora damicornis</i>	lace coral	Finely branched with many divisions; branches not thicker than a pencil; colonies small, up to 15 cm; bushy-shaped; light to dark brown.
<i>Pocillopora meandrina</i>	cauliflower coral	Heavy, leaf-like branches often forked near the end; brown to pink.
<i>Porites compressa</i>	finger coral	Finger-like branching with porous skeleton; tips of branches usually blunt or flattened; light-brown to yellow.
<i>Porites lobata</i>	Lobe coral	Branches form large lobes, never thin or finger-like; colonies may be huge, covering several meters or more; olive-green, brown, or blue-gray.
For additional information see the Hawaii Coral Reef Network at URL: http://www.coralreefnetwork.com/marlife/corals/corals.htm		

Data were also collected at MCTAB, which covers approximately 4.4 km² on the southeastern portion of Oahu. This site was particularly important since it includes locations where expeditionary assault operations, mine neutralization, swimmer insertion/extraction, and SPECWAROPS traditionally occur. Owing to wave action, there were few live coral colonies in the offshore areas near this site. The seafloor out to a distance of approximately 150 m from the beach consisted of sands.

3.0 Project Archive

3.1 General

Remote sensing campaigns at the NRL are of great importance since they are being conducted at various coastal sites and allow the collection of large scale (1:5,000) data. The archived datasets are crucial to generating useful relationships among California Bearing Ratio (CBR) and other fundamental material properties for soils, especially in selecting favorable littoral penetration points. CBR is derived from penetration tests that measure the pressure required to penetrate a soil. The USMC uses CBR to determine the load-bearing capacity of soils used for building roads and expeditionary airfields. Harder surfaces will have higher CBR ratings. In general, a CBR of 3 equates to tilled farmland, a CBR of 4.75 equates to turf or moist clay, while moist sand may have a CBR of 10. High quality crushed rock has a CBR over 80. Archiving this type of data from NRL's remote sensing campaigns complements existing databasing efforts such as the small scale (1:5,000,000) United Nations Food and Agriculture Organization's world soils map (see FAO-UNESCO 1974) and the medium scale (1:250,000) Soil and Terrain Database (see ISRIC 2004).

3.2 Geodatabase

When developing a geographic database or "geodatabase" to archive the results of feature classification, it's important to include, at a minimum, the imagery that each feature was based on, and the associated feature class or vector file. Figure 3 explains how the

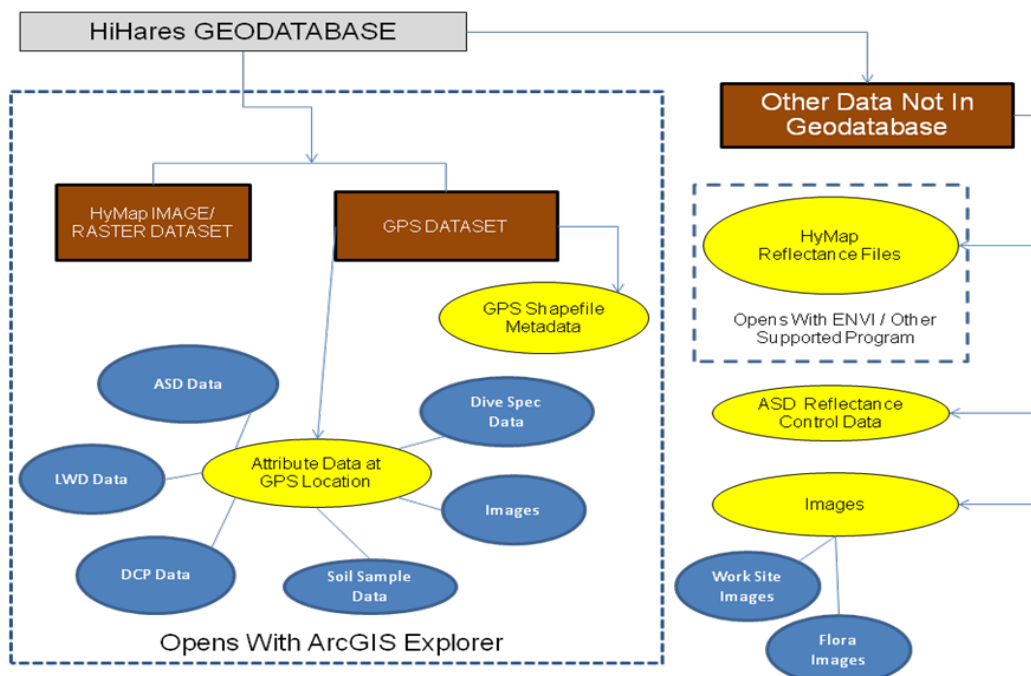


Figure 3. HAHARES'09 geodatabase development framework. HyMap and GPS datasets are opened with ArcGIS Explorer. Attribute data is stored in Microsoft Excel files, Word Pad read me files or as JPEG Images. Reflectance image (.bil) files need to be opened using ITT's ENVI.

features and images of this project were organized into the file geodatabase on the disk in which this geodatabase resides. When developing these geodatabases, we also included the intermediate files. Showing all the imagery analysis involved in creating the final result is helpful to those who want to repeat the same process for similar projects. Regardless of the number of files included, metadata is provided for each feature so others can understand how a particular file was produced and the proper way it should be interpreted.

The software package used in the development of the NRL CODE 7232 Hi-Hares geodatabase was ESRI's ArcGIS Explorer, which is a free Geographic Information System (GIS) software package based on ESRI's ArcGIS suite. The software package facilitates the input of local data as well as data from ESRI. Since this is a "free version" of ArcGIS, there are some capabilities that are lacking. Shapefile (a polygon shape with referenced geospatial information) production is lacking in ArcGIS Explorer 900 meaning, they cannot be brought into ArcGIS within the .kml or .shp format. However, shapefiles made in ArcGIS can be brought into the ArcGIS Explorer. ArcGIS users may find some compatibility issues with the ArcGIS Explorer, but in general, data created in ArcGIS can usually be brought into the ArcGIS Explorer. Keyhole markup language (.kml) and keyhole markup language-zipped (.kmz) files made in Google Earth and ArcGIS can be imported into ArcGIS Explorer.

ESRI's ArcGIS Explorer allows this GIS database to be applied by others that do not have access to ArcGIS. This allows for geodatabase developers at the NRL to present data findings to potential operators in the field that do not have access to imagery analysis software. There are some limitations with ArcGIS Explorer, but, this software package allows for the development of databases using Microsoft® Excel spreadsheets. This software package is available for download at URL:

[HTTP://WWW.ESRI.COM/SOFTWARE/ARCGIS/EXPLORER/INDEX.HTML](http://www.esri.com/software/arcgis/explorer/index.html)

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Specific types of data (raster, vector, and text) included in the HI-HARES geodatabase are as follows:

- **Imagery** - HyMap imagery was added into the ArcGIS Explorer program as well as the GPS shapefiles. HyMap reflectance files with the file extension .bil cannot be opened within the ArcGIS Explorer software. These files, which give spectral reflectance values at each the wavelength bands for all pixels in image study areas, can be analyzed to relate spectral reflectance to the variable range of environmental types, allowing detailed mapping.
- **Survey data** - Each of the Trimble differential GPS locations was developed into a shapefile either depicting a point, or a polygon where data was captured.
- **Cal/Val data** - The GPS shapefiles depict the location on the Earth's surface where instrument data were taken. The instrument data were then linked through ArcGIS Explorer to Microsoft Excel spreadsheets, JPEG images, or text documents with information about the data capture.
- **Metadata** - Digital photographs and field notes are provided that help explain the data.

These types of data will be further analyzed by NRL to develop innovative new products such as very shallow water bathymetric soundings and trafficability maps. HIHARES'09 was originally planned to provide notional data for amphibious planners. Products derived from HI-HARES will also be relevant to TS'09. Operators without ArcGIS or the Topographic Production Capability will be able to view geospatial information with ArcGIS Explorer. Development of an ArcGIS database is also planned for users requiring greater detail and ability to manipulate the data.

3.3 Digital Data Files

The data files are from the HIHARES'09 remote sensing campaign. Files are included for many of the tables, appendices, and figures used in this data report. Most of the map data and their metadata files, and a number of ArcGIS Explorer and ArcGIS projects are also included. Most of the data table files are tab-delimited text files, usable in spreadsheet and database software. The imagery and map data are in several formats for use by digital mapping software. Table 3 is a listing of available files that are not archived in the geodatabase.

Table 3. HIHARES'09 Data Files. Various types of files exist and include such entities as data tables, GIS files, spectra, and plot files. The data below are not provided in the ArcGIS Explorer viewer but reside on the geodatabase disk.

Path	Folder	File Types/Notes
\\HiHares_GD\\Attribute_Data\\Photos	2009	Work site photos. Photos of flora for ASD control. Photos are broken down by date captured.
\\HiHares_GD\\Attribute_Data\\	ASD	8 Folders of reflectance spectra arranged into folders of the location where the spectra were taken. Folders contain 116 log files and 116 .rfl files. A spreadsheet with edited reflectance data, complete reflectance data and graphs also appear.
\\HiHares_GD\\Attribute_Data\\	HyMap	Top level contains folders containing .tif files broken down by date, and a HyMap Radiance folder which contains folders including imagery quicklooks, and georeferenced raster images as well as intermediary files. Images to be opened in ENVI. Folders are divided into date and azimuth.

The types of data present in the HIHARES'09 campaign can be broken down into data archived in geographical form (which are presented through ArcGIS Explorer) and data that are not archived in geographical form. Data that are presented in the ArcGIS Explorer

format can be seen in Appendix D. The types of data accessed through Windows Explorer are listed in Table 3.

4.0 Visualization/Analysis

Trafficability is the ability of the terrain to support the movement of vehicles. Some of the important factors are vegetation density, bearing capacity, and shearing strength of the soil. Analysis was conducted to classify HSI of MCBH's littoral penetration areas as excellent, good, fair, poor, or bad in terms of trafficability.



Figure 4. FieldSpec®3 Spectroradiometer. Portable spectrometers are used to collect spectra (see ASD INC., Available online. URL: <http://www.asdi.com/products-fs3.asp>, Accessed on April 23, 2009).

Researchers collected reflectance data from field spectrometers and from airborne spectrometers in order to study specific landing beaches. The ASD, Inc. FieldSpec®3 Spectroradiometer that is depicted in Figure 4 was used during HIHARES'09. Vegetation density, grain sizes, beach composition, and soil moisture may be derived from the spectra, and from these intermediate parameters, trafficability parameters can be estimated. Spectra collected during HIHARES'09 are provided in Appendix E.

Dynamic modulus was determined by using a light weight deflectometer (LWD). The Zorn ZFG 2000 LWD is depicted in Figure 5. Some of the factors upon which soil modulus depends, and which are pertinent for HIHARES'09 are soil moisture content, soil stress level, stress history, and age of the soil. Records of dynamic modulus are provided in Appendix F.



Figure 5. Light Weight Deflectometer being used to determine dynamic modulus. See David J. White, 2007. Field Validation of Intelligent Compaction Monitoring Technology for Unbound Materials. Partnership for Geotechnical Advancement, Available online. URL: (http://www.ctre.iastate.edu/pubs/t2summaries/intel_compaction.pdf. Accessed on April 23, 2009).

A Kessler Dynamic Cone Penetrometer (DCP) was used in accordance with ASTM D 6951-03 in order to measure soil shear strength. It functions by striking a cone tipped rod with a freefalling weight, thereby driving the cone into the soil. The distance the cone penetrates is measured and the process is repeated until the desired depth is achieved. The recorded data are most commonly plotted as the number of blows divided by the penetration of the cone. For HIHARES'09 the CBR was determined using the Kessler DCP which is illustrated in Figure 6. Appendix G summarizes DCP testing done during HIHARES'09.



Figure 6. Dynamic Cone Penetrometers being used to determine CBR. The left panel depicts the DCP and magnetic ruler. The right panel illustrates the typical use of the DCP to measure CBR of a road.

Soil samples were collected with a corer. Soil moisture was determined by weighing a portion of the soil sample while wet and again after drying using a microwave oven. After sieving, the samples were described based on particle size (see Figures 7, 8, and 9). This allowed determination of the proportions of coarse, medium and fine sands, silt, and clay in a soil sample. A picture of a stack of sieves sitting in the shaker is provided in Figure 10. Appendix H summarizes soil analysis testing done during HIHARES'09.

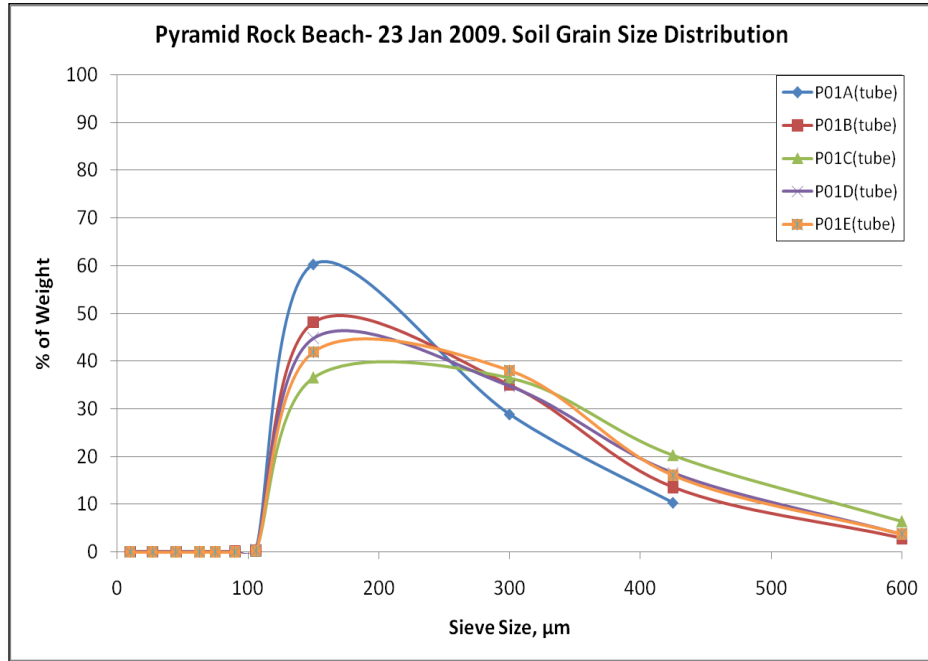


Figure 7. Grain size distribution along Pyramid Rock Beach transect.

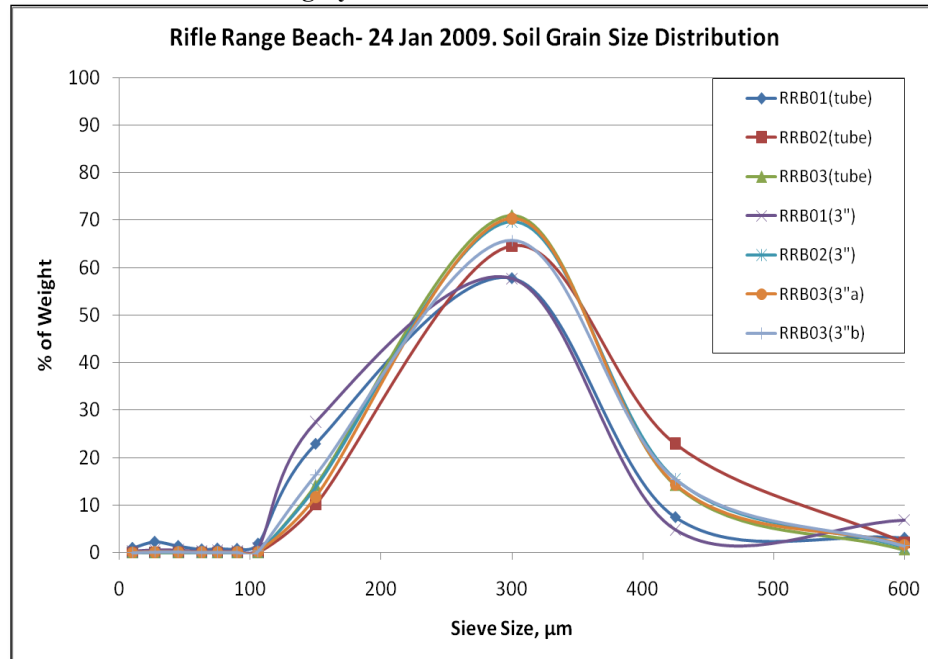


Figure 8. Grain size distribution along Rifle Range Beach transect.

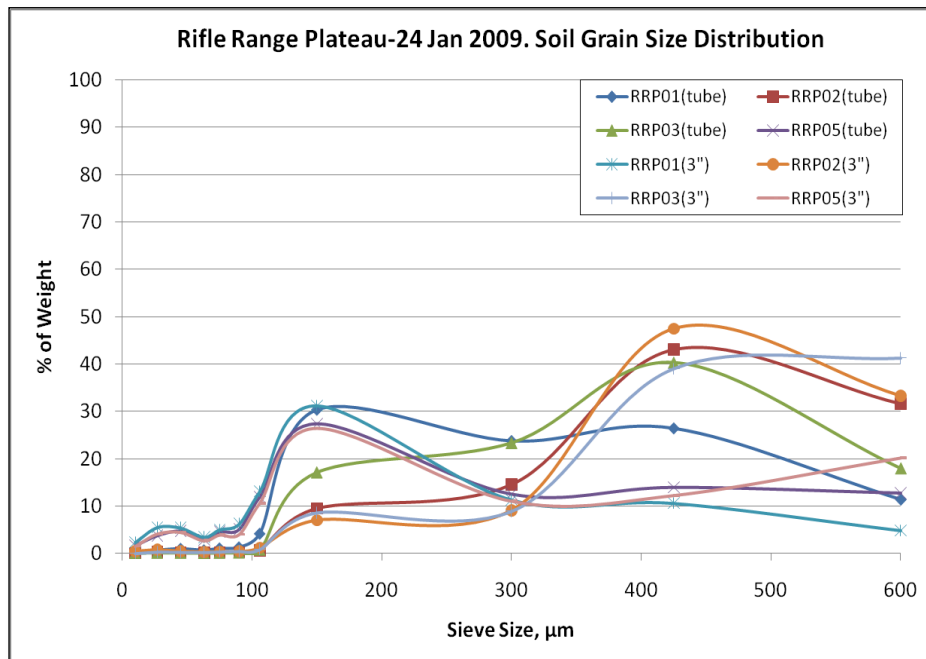


Figure 9. Grain size distribution along Rifle Range Plateau transect.

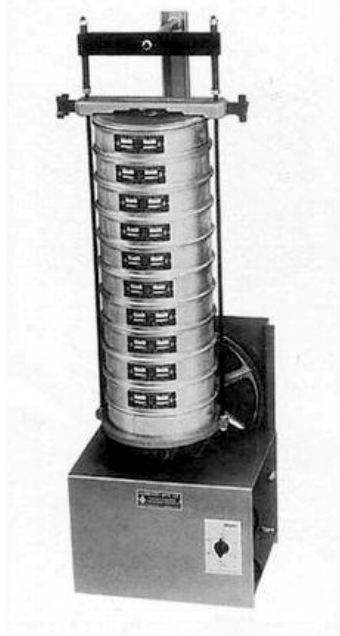


Figure 10. Sieves and shaker being used to determine grain size distributions. A Humboldt H4325 sieve shaker was used to determine grain size distributions (see LABEQUIP LTD. Available online. URL: www.labequip.com, Accessed on April 23, 2009).

5.0 Acknowledgments

This field work was a collective effort that involved a wide network of individuals and institutions beyond those that actually collected data, provided analyses, and wrote reports. Dr. Charles Bachmann was the principal investigator and was greatly aided by the efforts and insights of Mr. Gordon Mattis, the Science Advisor at Marine Corps Forces Pacific.

HI-HARES '09 was funded by the Office of Naval Research and the National Geospatial-Intelligence Agency. Of particular importance was Bob Rand who used HIHARES'09 for an additional target recognition study.

HIHARES'09 was a multi-institutional and integrated project that included NRL, ONR, NGA, SPAWAR, University of Hawaii, and industry. Collaborative research with the University of Hawaii and TRA, Inc. was facilitated by the National Defense Center of Excellence for Research in the Ocean Sciences. This collaborative effort related to sharpening HSI.

Research at NRL in the topic area of trafficability and very shallow water bathymetry has benefited from wise counsel and document reviews by Admiral Christopher Andreasen, Chief Hydrographer, Office of Global Navigation, National Geospatial-Intelligence Agency.

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APPENDIX A

Web Resources

1. Introduction

Selected Web Links that complement this data report are provided below:

CEROS: National Defense Center of Excellence for Research in Ocean Science. Available online. URL: <http://www.ceros.org>. Accessed on January 6, 2008.

A CEROS funded project which included Technology Research Associates from Hawaii and facilities at the University of Hawaii was included in HIHARES'09. These investigators developed methods that will enhance imagery for NRL's HSI exploitation techniques. TRA accomplished this by adding high-resolution RGB cameras to the HyMap payload. TRA's research involved the use of image enhancement between HyMap and a higher resolution RGB camera known as WASABI.

Harold L. Lyon Arboretum. Available online. URL: www.hawaii.edu/lyonarboretum. Accessed on January 20, 2009.

During HIHARES'09, research scientists visited the approximately 1 km² Lyon Arboretum to obtain spectra of vegetation indigenous to Oahu and from several specialty gardens, spectra of plants common to Australia.

Hawaii Coastal Geology Group, University of Hawaii. Available online. URL: <http://www.soest.hawaii.edu/coasts/data/oahu/pdcimagery.html>. Accessed on December 31, 2008.

A database of shoreline imagery for the Hawaiian Islands that was used for research design and analysis.

Honolulu Botanical Gardens. Available online. URL: <http://www.co.honolulu.hi.us/parks/hbg/index1.htm>. Accessed on January 7, 2008.

During the Mid Planning Conference for Talisman Saber'09 and during HIHARES'09, research scientists visited the approximately 0.1 km² Foster Botanical Garden to obtain spectra of vegetation indigenous to Oahu and from several specialty gardens, spectra of plants common to Australia. On November 19, 2008, Dr. Chip Bachmann, Mssrs Mattis and Nichols, and Capt Chris Jones were aided by Ms. Naomi Hoffman, a botanist, in the collection of data on species listed in Table A-1. Field spectra were collected from selected leaf samples.

Table A-1. Plant species studied at Foster Botanical Garden on November 19, 2008.

Scientific Name	Common Name	Remarks
<i>Acacia koa</i>	Koa	Endemic to Hawaiiia.
<i>Aleurites moluccana</i>	Kukui	Distributed throughout tropical regions.
<i>Chamaesyce degeneri</i>	Akoko	Endemic to Hawaiiia.
<i>Coix lacryma-jobi</i>	Job's tear	Common along streams and ditches in Hawaii.
<i>Colocasia esculenta</i>	taro	Native to tropical Polynesia and southeastern Asia.
<i>Cordia sebestena</i>	Kou haole	Found worldwide, mostly in warmer regions.
<i>Cordyline fruticosa</i>	Ti plant	It is native to tropical Asia, Australia, the Indian Ocean, and parts of Polynesia.
<i>Curculigo capitalata</i>	palm grass	Arching palm-like leaves, evergreen in protected areas, small yellow flowers in summer
<i>Gossypium tomentosum</i>	Ma'o	A shrub found in Hawaii that grows in dry, rocky, or clay coastal plains.
<i>Hibiscus brackenridgei</i>	Ma'o Hau Hele	Found in dry forests and Hawaiian tropical low shrublands.
<i>Hyophorbe verschaffeltii</i>	spindle palm	Found in tropical coastal savannas and hilly forests worldwide due to cultivation.
<i>Macrozamia miquelii</i>	Zamia bush	Found in Queensland Australia.
<i>Myoporum sandwicense</i>	Naio	Endemic to Hawaii.
<i>Ophiopogon japonicus</i>	mondo grass	Ground cover found in temperate and tropical Asia.
<i>Pandanus tectorius</i>	Hala	Found on Pacific islands, in Micronesia, in Melanesia, and as far west as northern Australia.
<i>Pittosporum undulatum</i>	mock orange	Native to the coastal belt and mountains of south-eastern Australia.
<i>Pritchardia remota</i> ¹	Loulu	Palm tree found in Hawaii and being cultivated in botanical gardens.
<i>Terminalia catappa</i>	tropical almond	Widespread in subtropical and tropical zones of Indian and Pacific Oceans; planted extensively throughout the tropics.
<i>Thespesia populnea</i>	Milo	Tropical and subtropical distribution.

¹ Several *Pritchardia* species are listed as endangered under the US Endangered Species Act and are only found in cultivation in botanical gardens.

<i>Veitchia montgomeryana</i>	Montgomery palm	Native to Vanuatu.
For specifics on Hawaiian plants see Eileen Herring, Thesis Project: Hawaiian Native Plant Propagation Database, Available online. URL: http://pdc.ctahr.hawaii.edu:591/hawnprop/default.htm , Accessed November 17, 2008.		

Marine Corps Base Hawaii. Available online. URL: <http://www.mcbh.usmc.mil>. Accessed on February 17, 2008.

NRL researchers were required to coordinate with various points of contact at Marine Corps Base Hawaii. Several field reconnaissance trips and meetings were conducted with personnel from the Operations and Training Directorate, especially individuals involved with range control and waterfront operations.

National Oceanic and Atmospheric Administration, National Weather Service Forecast Office, Honolulu.
http://www.prh.noaa.gov/hnl/pages/cli_graphs.php?station=PHNG&mo=JAN. Accessed on January 8, 2009.

Meteorological data for Marine Corps Air Station (MCAS) Kaneohe Bay covering the study period can be accessed from the National Weather Service. This data is useful to atmospherically correct hyperspectral imagery (HSI).

U.S. Marine Corps Forces Pacific. Available online. URL: <http://www.mfp.usmc.mil>. Accessed on January 7, 2008.

Professional Military Education was conducted at MARFORPAC by NRL and AFRL scientists during January 2008 on HSI and the TACSAT-3/ARTEMIS experiment. The Chief of Staff directed the Science Advisor to include ARTEMIS as an experiment during TALISMAN SABER 09. Primary sponsors for the planning of HIHARES'09 as a preparation for Talisman Saber were the Science Advisor, AC/S G-2, representatives from the MARFORPAC Experimentation Center (MEC), and exercise planners from the PACOM J-8. Exercise proposals and presentations were delivered to the MEC and PACOM J-8. Data collected during HIHARES was planned to be made available to various intelligence personnel from 31st MEU, MARFORPAC, MCIA, and NAVOCEANO.

APPENDIX B

Flight Lines

1. Introduction

HIHARES'09 flight lines were planned to achieve a nominal ground sample distance (GSD) of about 3m and an approximate swath is about 1.6 km. An overlap of approximately 20% (which is about 300 m) between adjacent flight lines was achieved in order to prevent any data gaps from small variations in the planned flight-lines. To minimize glint from the water, flights were flown when solar zenith angles were between 30-60°. In addition, flights were flown into and out of the sun as illustrated in the following solar azimuth heading figures. Priority flight lines are shown in red, and all other potential lines appear in orange. Each flight line is indicated by a box showing swath (about 1.6 km at the planned GSD, and the extent (about 20 km for each line).

B-3

APPENDIX C

Quicklook Imagery

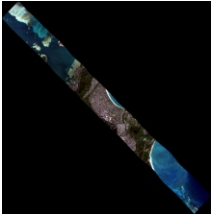
1. Introduction

Imagery quicklooks are georectified images that show the extent of the HSI taken during the HIHARES'09 campaign. Programs such as ArcMap and ArcGIS Explorer cannot fully utilize the capabilities of HSI like ENVI can, so quicklook images are developed for quick viewing of the flight line's position, image quality, and the presence of clouds. The quicklook images are RGB images which are displayed as JPEG or TIFF format. The time of each image's center line is listed in Table C-1. The time is in Hawaiian standard time (HST, UTC-10).

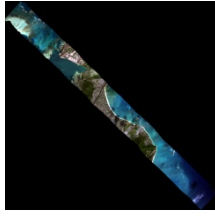
Table C-1. HIHARES '09 HyMap imagery flight times.

Flight line	Date	Time of flight line center (HST)
Az 136 A03	24 Jan 2009	11:12:39
Az 136 A04	24 Jan 2009	11:24:32
Az 136 A05	24 Jan 2009	10:47:52
Az 136 A06	24 Jan 2009	10:21:40
Az 136 A07	24 Jan 2009	10:35:47
Az 136 A08	24 Jan 2009	11:27:14
Az 136 B20	24 Jan 2009	10:08:45
Az 171 A01	24 Jan 2009	11:41:00
Az 171 A02	24 Jan 2009	11:52:36
Az 171 A03	24 Jan 2009	11:27:41
Az136 A02	30 Jan 2009	10:30:24
Az136 A03	30 Jan 2009	10:19:23
Az136 A04	30 Jan 2009	10:42:23
Az136 A05	30 Jan 2009	10:54:06
Az136 C21	30 Jan 2009	11:21:43
Az171 A09	30 Jan 2009	11:53:17
Az148 A1	31 Jan 2009 AM	11:28:20
Az148 A2	31 Jan 2009 AM	11:18:39
Az148 A3	31 Jan 2009 AM	
Az148 P1	31 Jan 2009 AM	11:48:17
Az148 P2	31 Jan 2009 AM	11:41:53
Bellows	31 Jan 2009 AM	12:08:33
Az148 A2	31 Jan 2009 PM	14:03:36
Az148 P1	31 Jan 2009 PM	
Az148 P2	31 Jan 2009 PM	
Random	31 Jan 2009 PM	14:25:21
Az148 A1	1 Feb 2009	11:02:35
Az148 A1 H	1 Feb 2009	
Az148 P1	1 Feb 2009	11:18:47
Az148 P2	1 Feb 2009	11:21:52
AZ148 P2 H	1 Feb 2009	
Az171 B11	1 Feb 2009	
Az171 B12	1 Feb 2009	12:19:49
Az171 B13	1 Feb 2009	12:31:46
Az171 B14	1 Feb 2009	12:45:18
Az171 B15	1 Feb 2009	12:57:39

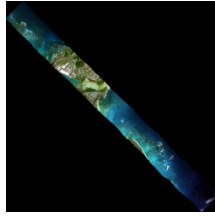
2. Quicklook Imagery



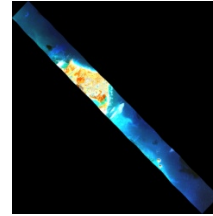
az136_a03_geo



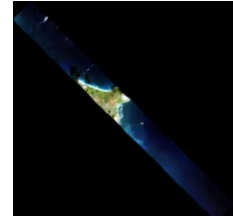
az136_a04_geo



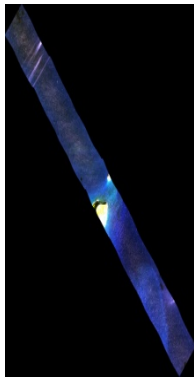
az136_a05_geo



Az136 a 06 geo a



az136_a07_geo



az136_b20_geo



Az171_A01_geo

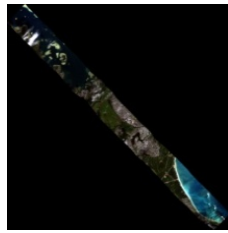


Az171_A02_geo

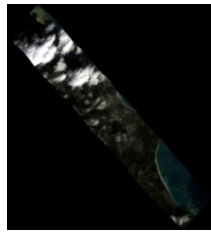


Az171_A03_geo

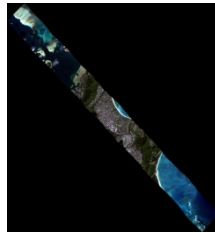
January 24, 2009 HyMap Imagery. Sky conditions were coded as “clear” at the Kaneohe Bay weather station around 0457, from 0757 to 0857, and from 1357 to 1657 HST.



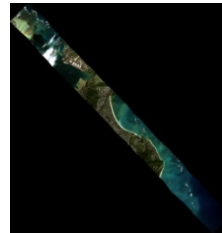
az136_a02_geo



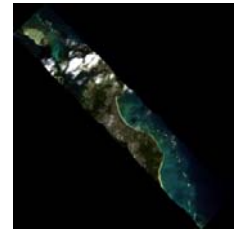
az136_a02h_geo



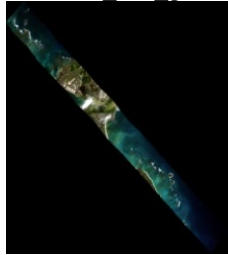
Az136_a03_geo



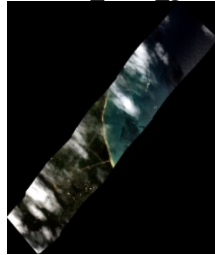
az136_a04_geo



az136_a04h_geo



az136_a05_geo

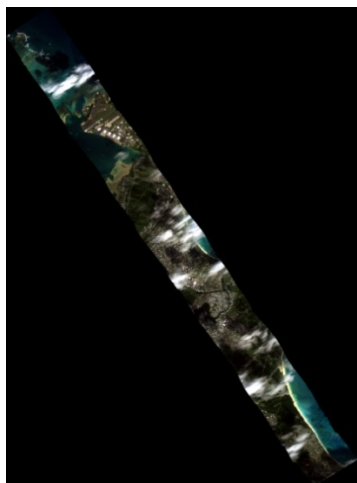


az136_c21_geo

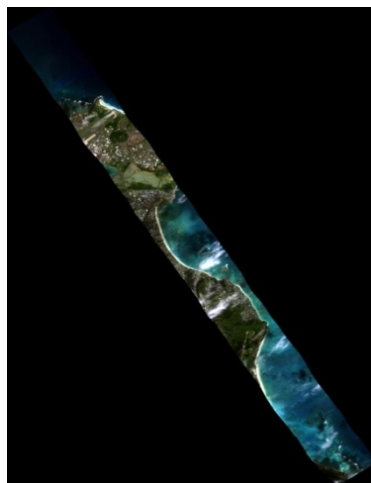


Az171_a09_geo

January 30, 2009 HyMap Imagery. Sky conditions were coded as “scattered clouds” and “partly cloudy” throughout the day at the Kaneohe Bay weather station. At 1210 HST sky conditions were recorded as “mostly cloudy”.



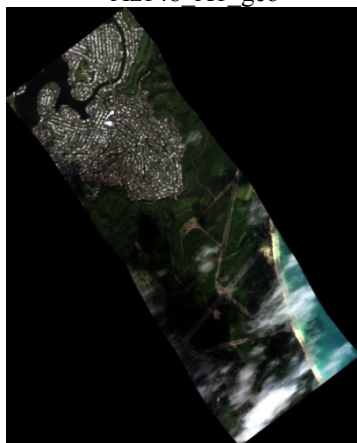
Az148 A1_geo



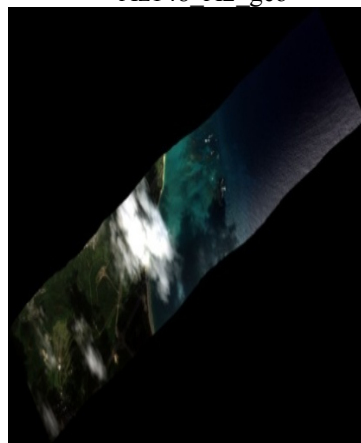
Az148 A2_geo



Az148 A3_geo



Bellows_geo

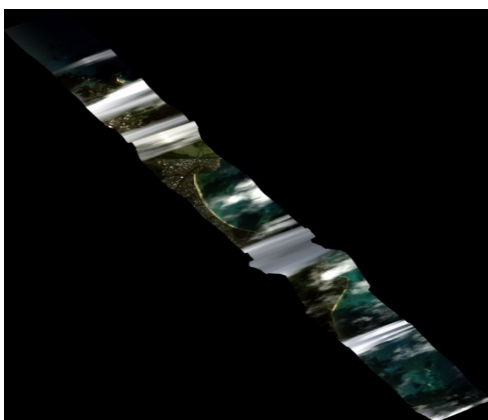


Az148_P1_geo



Az148_P2_geo

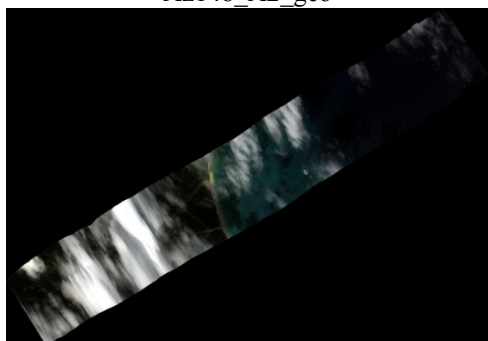
Jan 31, 2009 AM HyMap Imagery. Sky conditions were coded as “clear” at the Kaneohe Bay weather station from 0057 to 0357 and around 0857 HST.



Az148_A2_geo



Az148_P1_geo

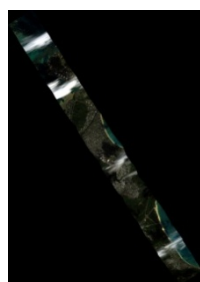


Az148_P2_geo



Random_geo

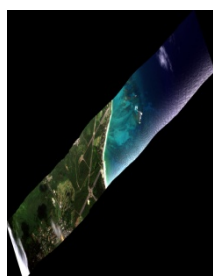
January 31, 2009 PM HyMap Imagery. Sky conditions were coded as “clear” at the Kaneohe Bay weather station around 1357, from 1557 to 1657, and from 2057 to 2357 HST.



Az148 A1_geo



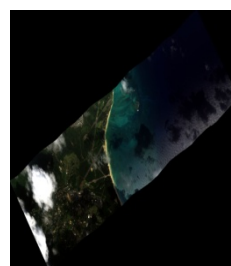
Az148 A1_H_geo



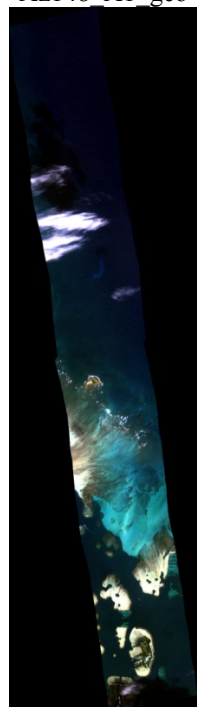
Az148 P1_geo



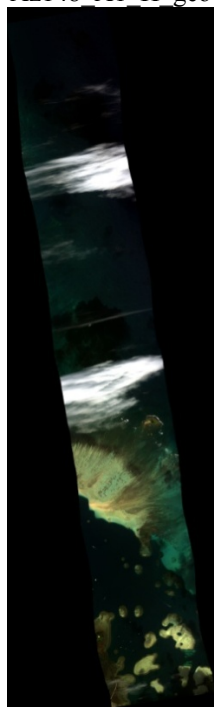
Az148 P2_geo



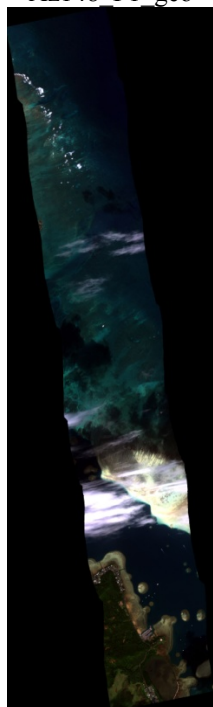
AZ148 P2_H_geo



Az171_B11_geo



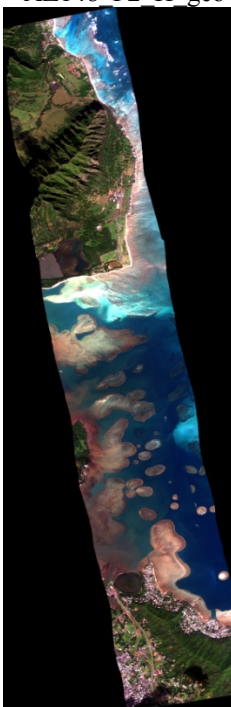
Az171_B12_geo



Az171_B13_geo



Az171_B14_geo



Az171_B15_geo

February 1, 2009 HyMap Imagery. Sky conditions were coded as “clear” at the Kaneohe Bay weather station from 0257 to 0357, around 0657, from 0957 to 1157, and from 1457 to 1757 HST.

APPENDIX D

Geodatabase

1. Introduction

A geodatabase is an information database that contains data with a geographical component meaning that it is a collection of feature datasets for use within a GIS such as ArcMap or ArcGIS Explorer. ArcMap is contained in ArcGIS and is a proprietary software program developed by Environmental Systems Research Institute, INC (ESRI). ArcGIS Explorer is a free software version of ArcGIS which was developed by ESRI and is used mainly for visualization and presentation purposes. The software program is similar to Google® Earth and allows for opening shapefiles and adding points and shapes to the viewer, but creating and editing shapefiles are not possible in this version. The HIHARES'09 geodatabase was developed to be viewed in both ArcGIS and ArcGIS Explorer. The ArcGIS Explorer version was made in order to accommodate those who wanted to see the positions and type of data collected but do not have access to ArcGIS. Those with access to ArcGIS and the applications of ArcMap, ArcToolbox, and ArcCatalog will have access to the full capabilities of the geodatabase and be able to create and edit data to suit their needs.

To view the geodatabases, navigate to either the *.mxd* or *.nmf* file in the HIHARES_GD folder in Windows Explorer. By opening the *.mxd* file, the ArcMap (ArcGIS) version of the geodatabase is opened. Clicking the *.nmf* file opens the ArcGIS Explorer 900 version.

Each of the areas of data collection was identified with a marker, such as a dot for GPS data, a flag for attribute data associated with the location, or polygon box for general location (Table D-1). GPS locations in the geodatabase (both versions) are identified with red dots.

Table D-1 Geodatabase ArcGIS Explorer Locator Key.

Location	Attribute Data Flag Color	Date Data Taken	Locator Polygon Color	GPS Dot/Polygon Color
Pyramid Rock	Checkered Black and White	23 Jan 2009	Black	Red
Rifle Range Beach	Yellow	24 Jan 2009	Yellow	Red
Rifle Range Plateau	Red	24 Jan 2009	Red	Red
Koa Beach	White	25 Jan 2009 1 Feb 2009	White	Red
Bellows North	Green	30 Jan 2009	Green	Red
Bellows South	Green	30 Jan 2009	Green	Red
Bellows Middle	Green	31 Jan 2009	Green	Red

2. ArcGIS Explorer 900 Version

The ArcGIS Explorer version allows for the visualization and presentation of data collected during HIHARES'09. Content in this version includes data collected during HIHARES'09 as well as additional data provided by multiple sources. The viewer of ArcGIS Explorer 900 can be seen in Figure D-1. The display is similar to ArcMap which has “Tools” along the top, and a “Contents” section which displays the available layers presented in the “Map View” section. The ArcGIS Explorer 900 “Tools” section has similar tabbed navigation as the Microsoft® Office 2007 series.

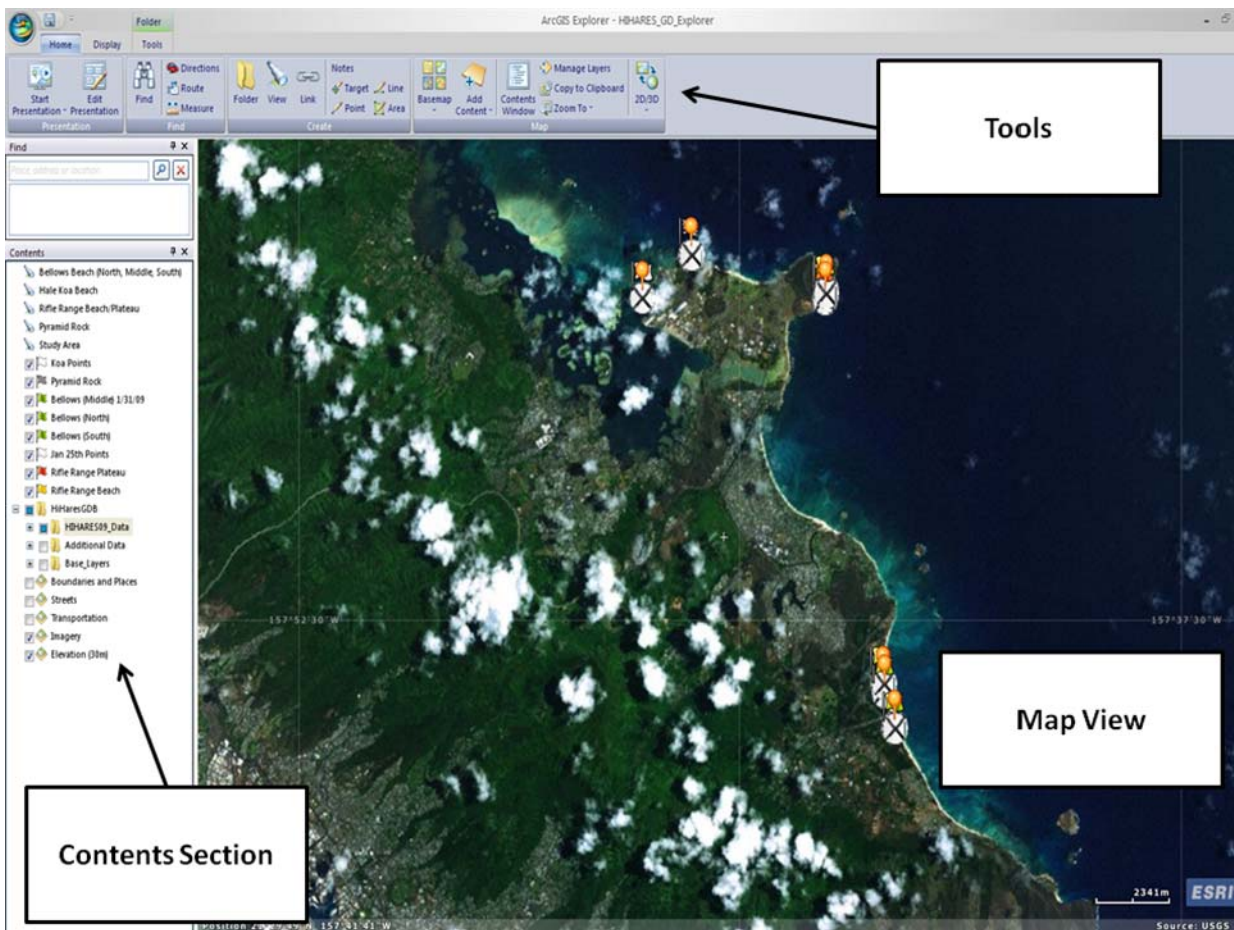


Figure D-1 Sections of ArcGIS Explorer 900.

Figure D-2 displays the items in the contents view of the ArcGIS Explorer version. The data collected during the HIHARES'09 campaign is broken down into three major sections. The “HIHARES09_DATA” section contains the data collected at the site by the NRL team and products developed from this data; the “Additional Data” section contains data obtained from multiple sources complementary to the data collected during the HIHARES'09 experiment; and the “Base Layers” section contains background shapefiles for viewing, and this section is especially useful if an internet connection cannot be obtained (ArcGIS Explorer imagery

background “basemap” will not be available).

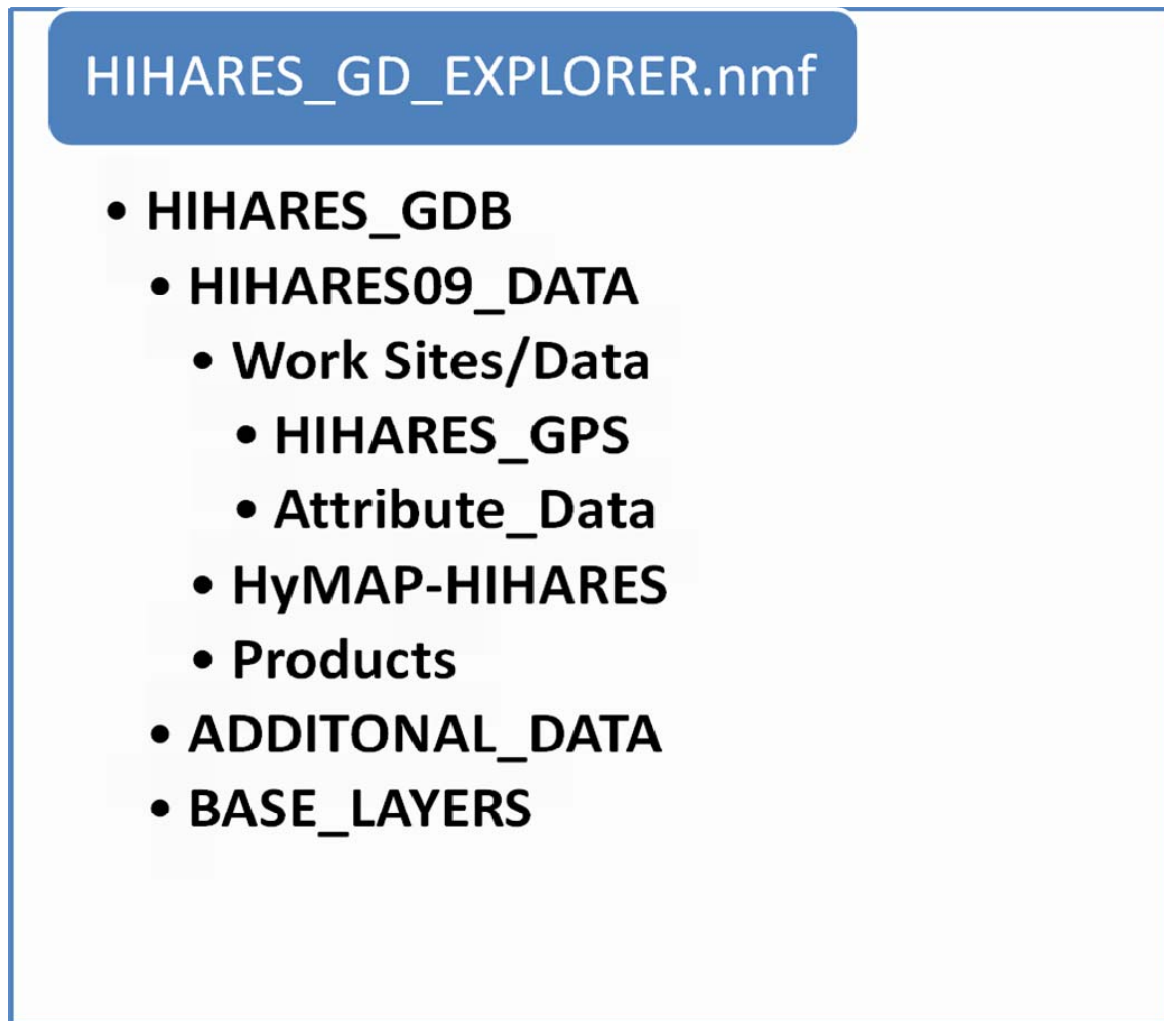


Figure D-2 ArcGIS Explorer geodatabase shapefile groupings.

Figure D-3 displays a screen capture of the HIHARES’09 collected data. In the figure, red dots signify the GPS points where ground data were collected. HyMap imagery is seen as overlapping flight lines and can be seen behind both sets of GPS data points. The types of data can be turned off or on (viewed or not viewed) by checking or unchecking the box in the “Contents” section.

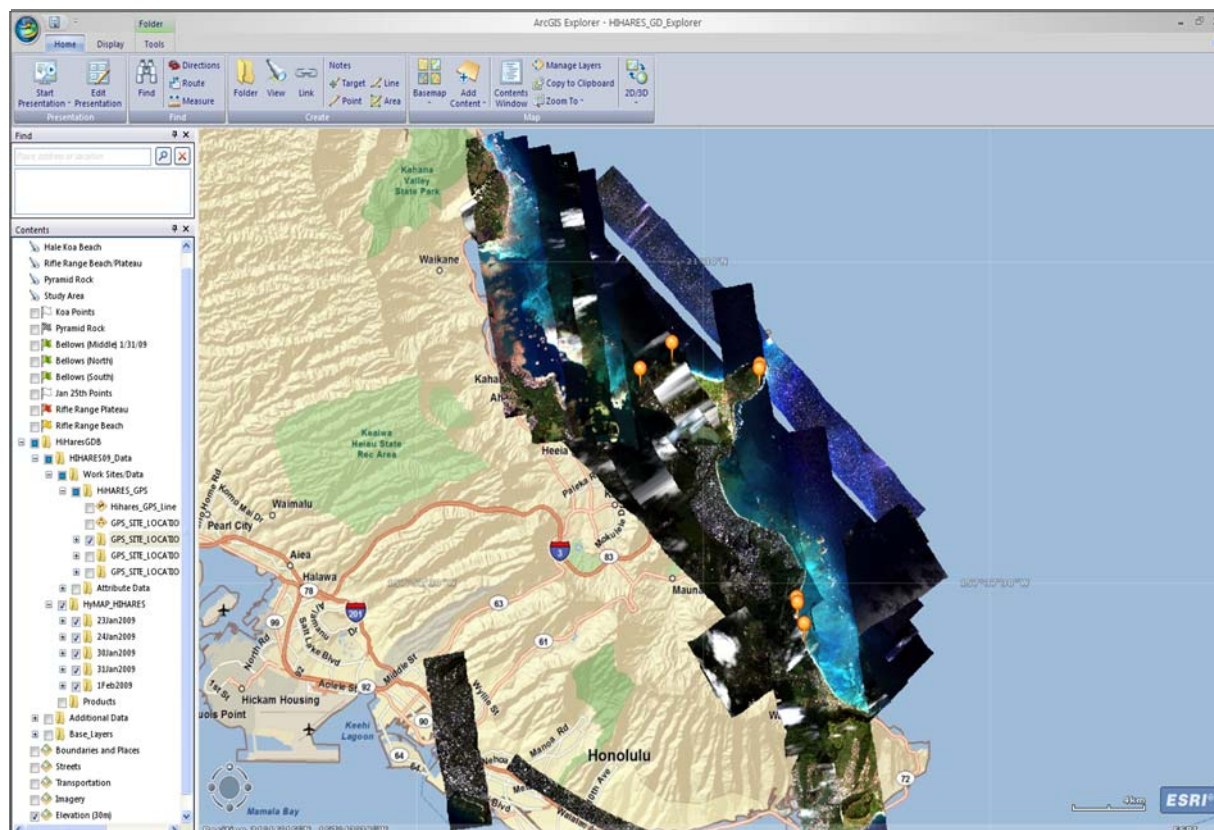


Figure D-3 Screen capture of the HIHARES'09 geodatabase viewed in ArcGIS Explorer 900. Display of HIHARES09_DATA collected at site. Red dots signify GPS points where data were collected. HyMap imagery can also be seen.

Figure D-4 displays two screen captures concerning the access of GPS attribute data collected during the HIHARES'09 campaign. The top portion of the figure (marked A) shows the pop-up window that is displayed when a GPS_SITE_LOCATIONS_PHOTOS (red pushpin) point is clicked. When clicked, a photo will pop-up in another window. The bottom portion of the figure (marked B) shows the attribute table information when GPS_SITE_LOCATIONS_TABLE_INFO (Crosshair Circle) point is clicked. The table shows the site's name, position, time and date, locality, absolute file pathnames/relative pathnames to connect to a photograph of the site, and a link to the attribute data for all sites.

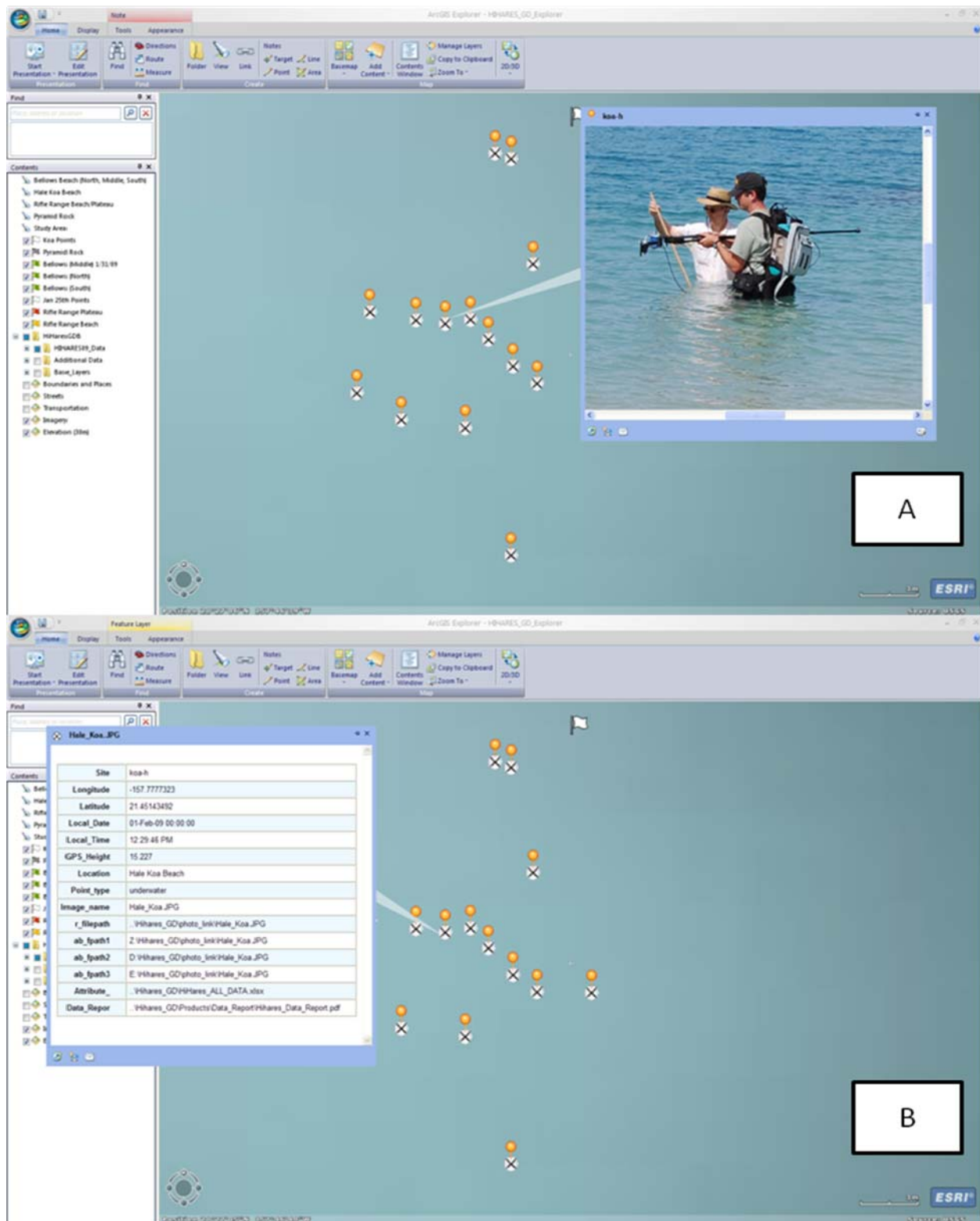


Figure D-4 Pop-up window display of GPS point attribute data. (A) HIHARES'09 GPS Work location photo. (B) Access of work location attribute data by clicking crosshair icon.

3. ArcGIS Desktop (Arcview) Version

The ArcGIS Desktop version allows for manipulating and editing datasets as well as viewing the data. Figure D-5 displays a screen capture of the ArcMap version of the geodatabase with sections of the ArcMap interface labeled. The “Table of Contents” section displays the data available for viewing in the “Map Viewer Section.” The “Data Frame” contains all the layers that will be seen in the “Map Viewer.” “Layers” represent geographic data, usually grouped in a single theme of shapefiles or rasters. A “shapefile” is a non-topological format for storing the geometric location and attribute information of geographic features, and these geographic features are the individual components that describe the theme in a “Layer.” Shapefiles can represent point, line, or area (polygon) vector files and can be turned off from viewing in the “Map Viewer” by checking the box at the side of the shapefile’s name in the “Table of Contents” section. The “Menu Bar” is located at the top of ArcMap and contains drop down menus. The “Tools” toolbar contains basic navigational tools used for navigation in the “Map Viewer.” The “ArcToolbox Window” allows the more advanced user to gain access to tools to edit the data.

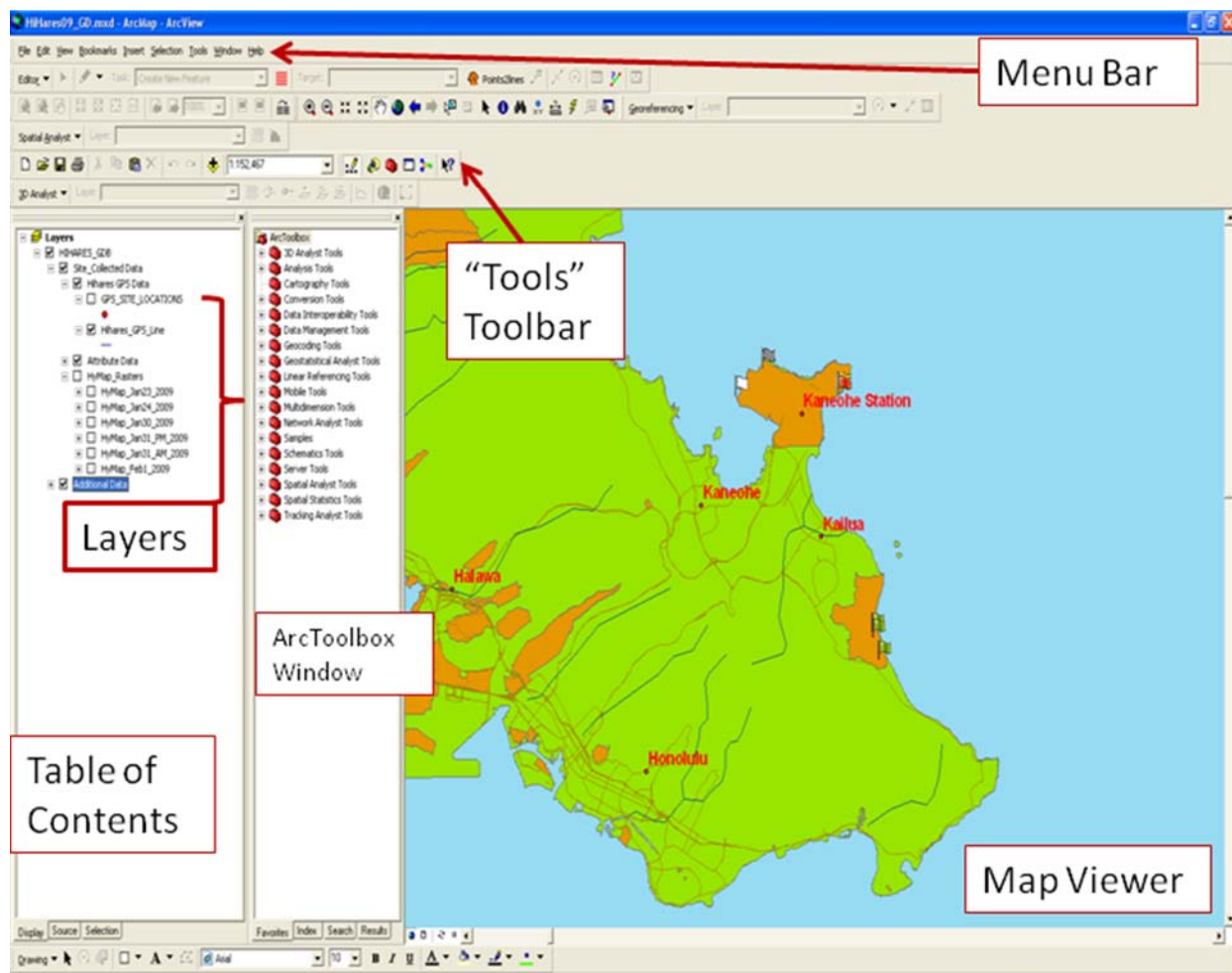


Figure D-5 General sections of ArcMap.

Figure D-6 displays the data groupings seen in the “Table of Contents” section of ArcMap. The data collected during the HIHARES’09 campaign is broken down into three major sections. The “HIHARES09_Collected Data” section contains the data collected at the site by the NRL team and products developed from this data; the “Additional Data” section contains data obtained from multiple sources complementary to the data collected during the HIHARES’09 experiment; and the “Base Layers” section contains background shapefiles for viewing.

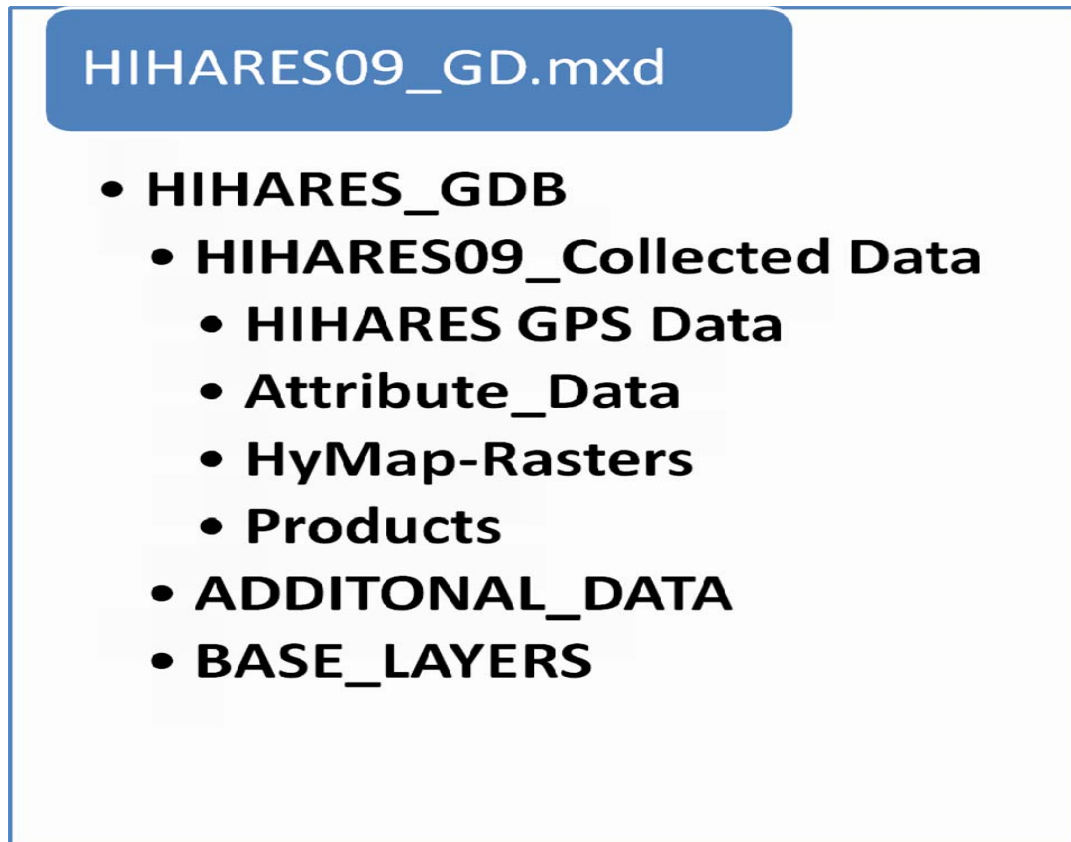


Figure D-6 ArcMap geodatabase data groupings.

By using the identify feature tool, one can view attribute data of each shapefile. Figure D-7 shows various data available when one clicks GPS_SITE_LOCATIONS point shapefile. In the figure, box A shows the pop-up information that appears when one clicks on yellow hyperlink icon for “ab_fpath..”(photograph link). The yellow lightning bolt represents a hyperlink to either a URL, photograph, document, or Excel spreadsheet. Box A shows the pop-up of the photograph linked to that work site. When the hyperlink to the data report is clicked, a associated data report from the HIHARES’09 experiment is displayed in another window. Box C displays an excel spreadsheet which contains all attribute data collected at the site. One can also navigate through Windows ® Explorer to access the attribute data which is hyperlinked above.

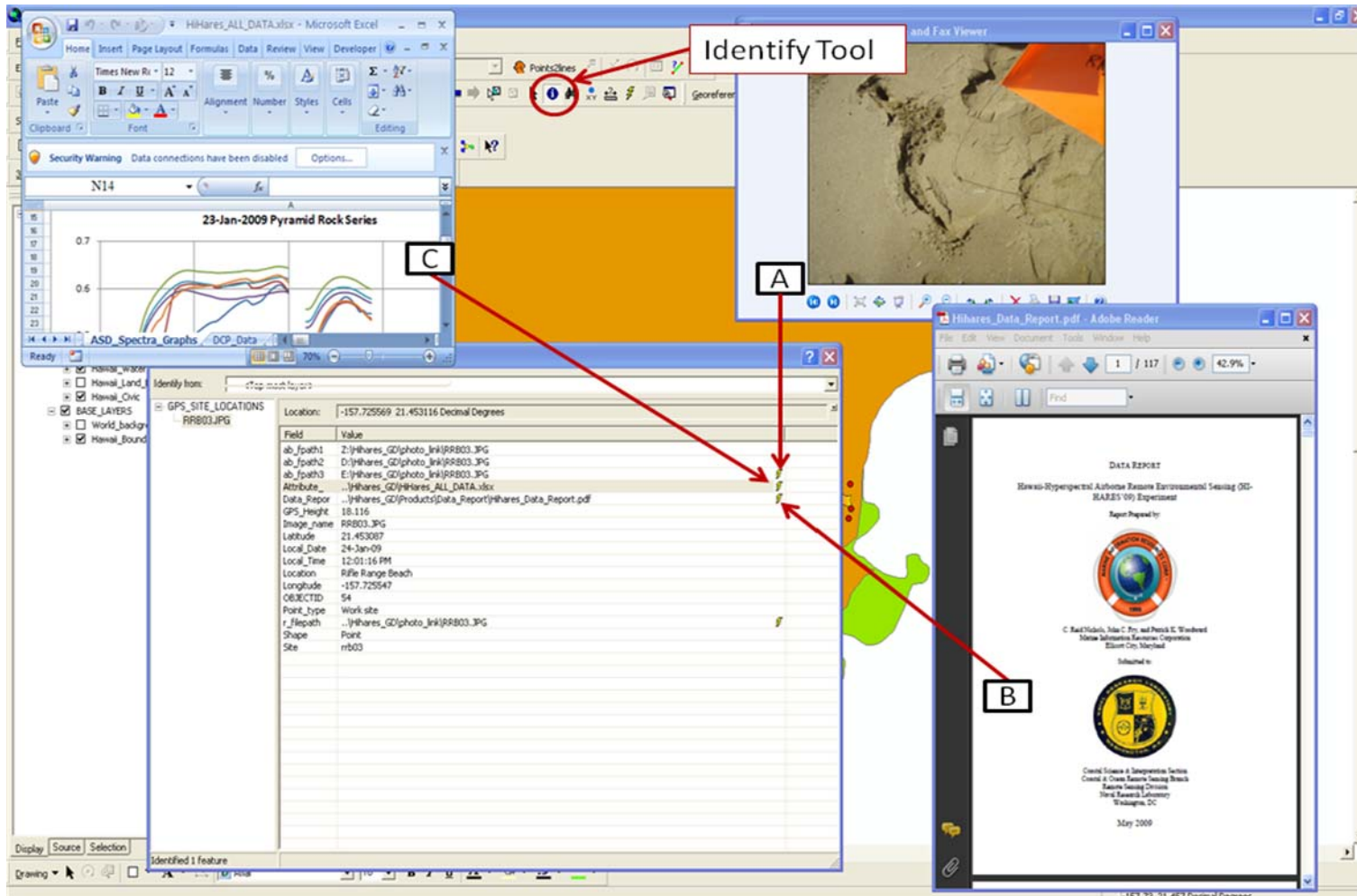


Figure D-7 Using the identify feature tool to access GPS work site attribute data. (A) Site photograph accessed via clicking on a hyper-link (B) Data Report accessed via clicking on a hyper-link (C) HIHARES_ALL_DATA.xls file (Attribute data collected during campaign).

APPENDIX E

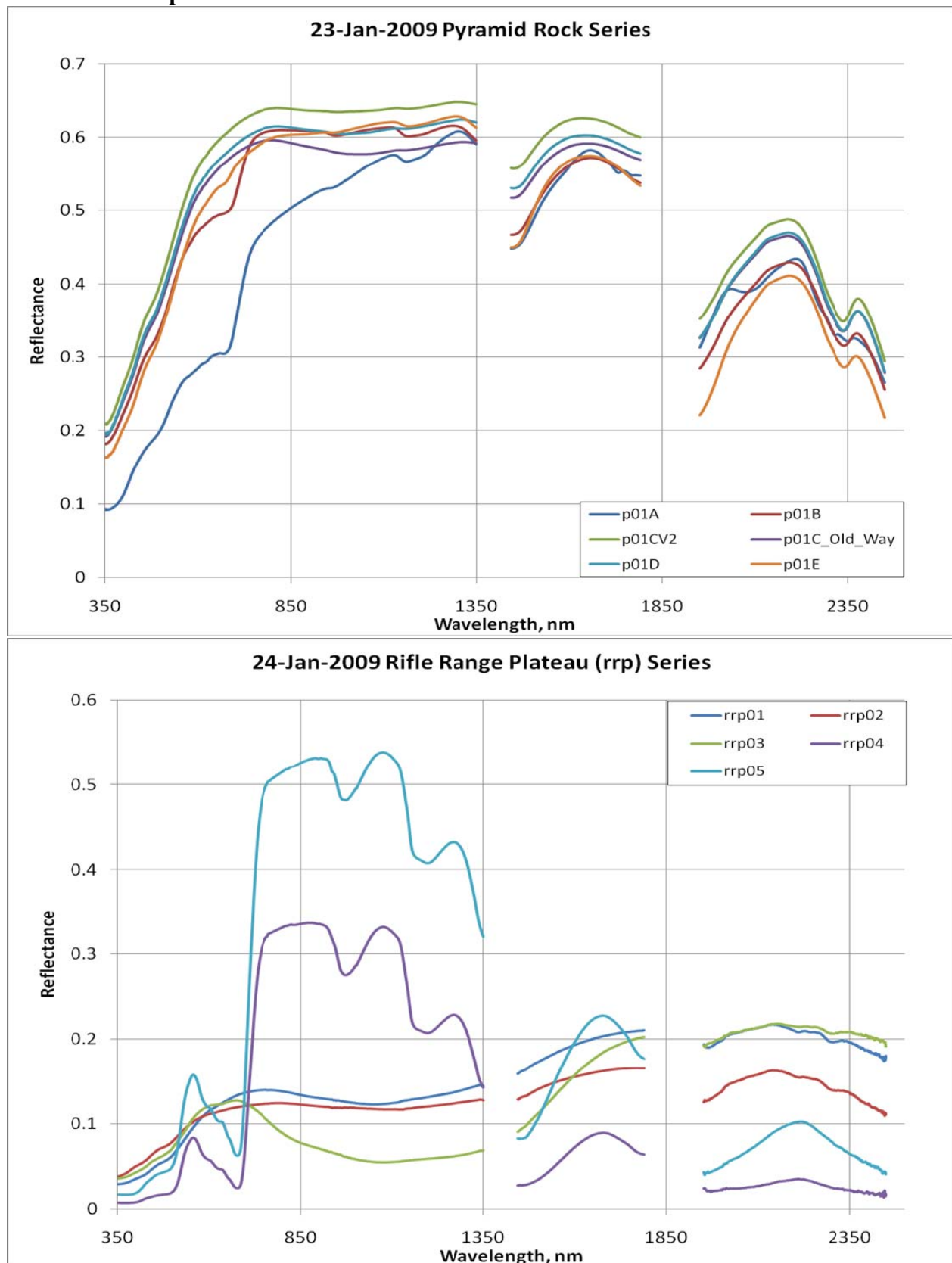
Spectra

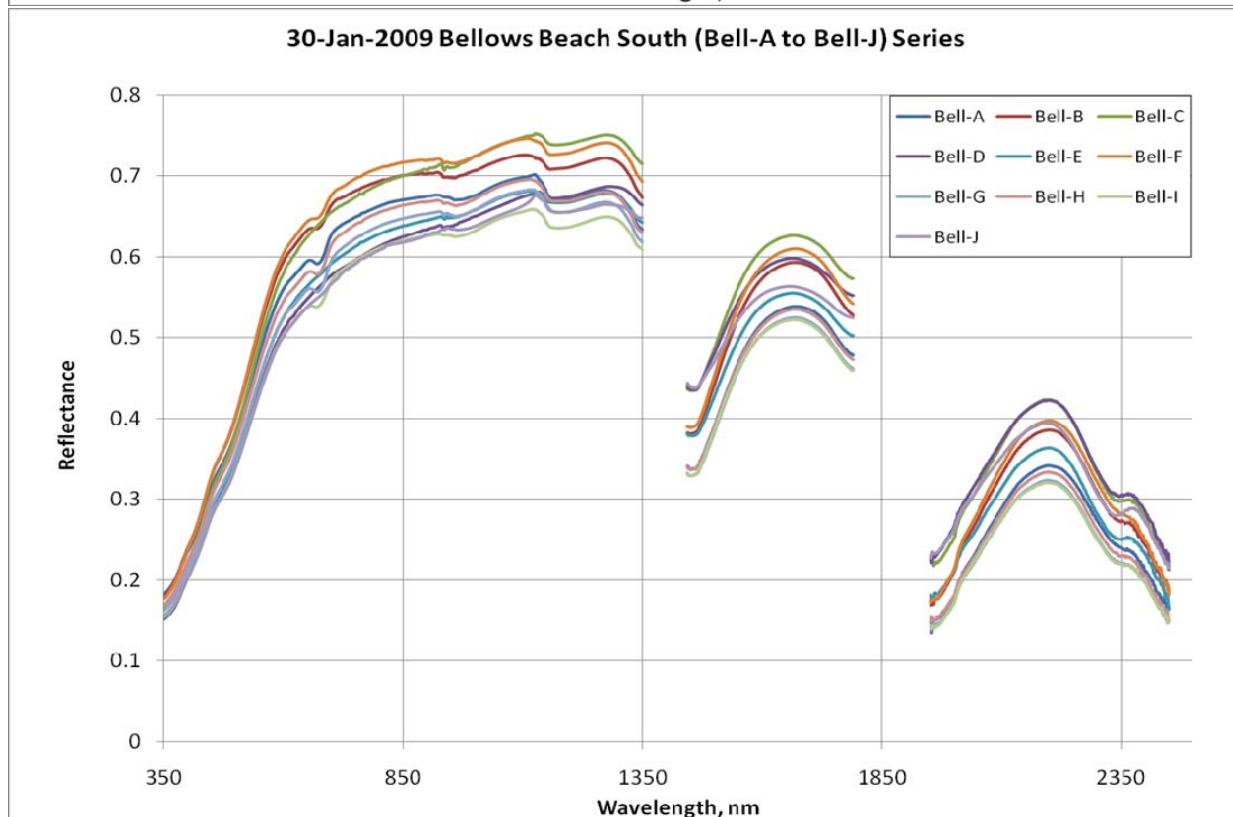
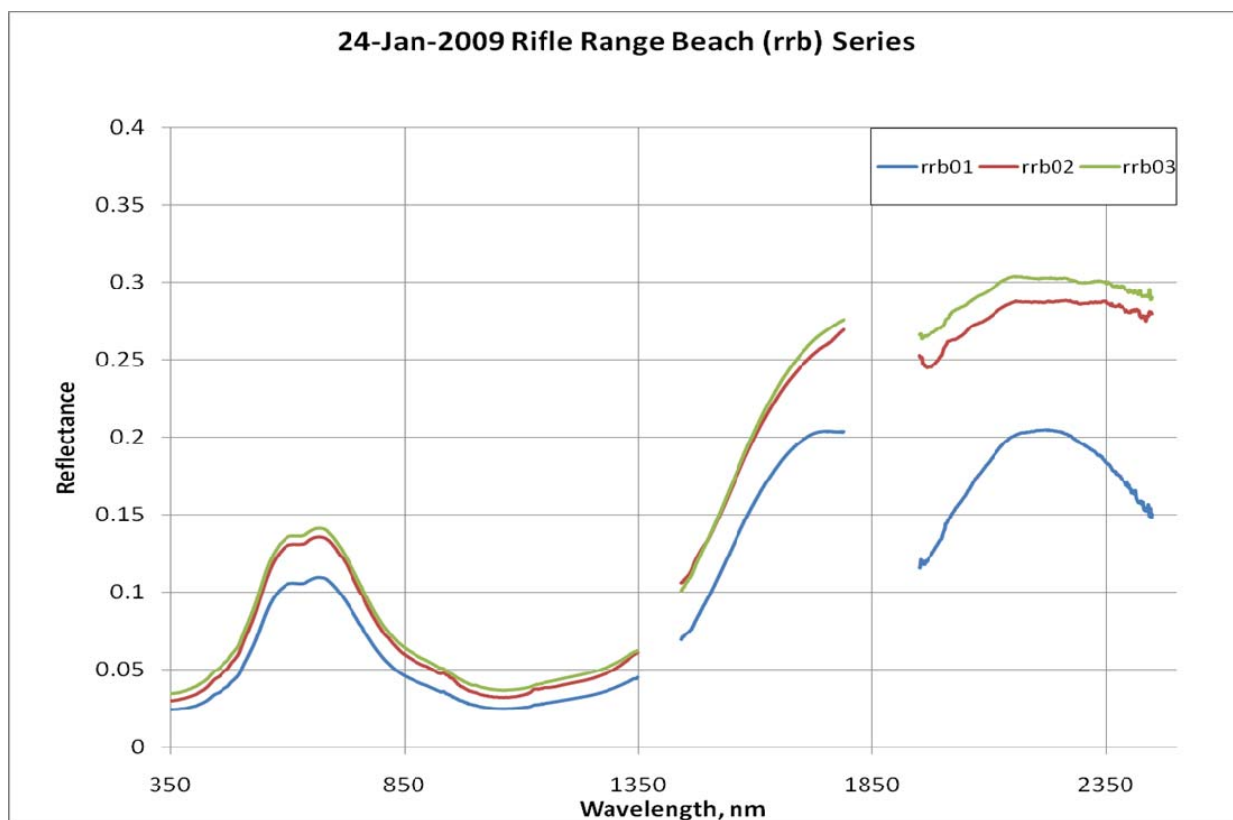
1. Introduction

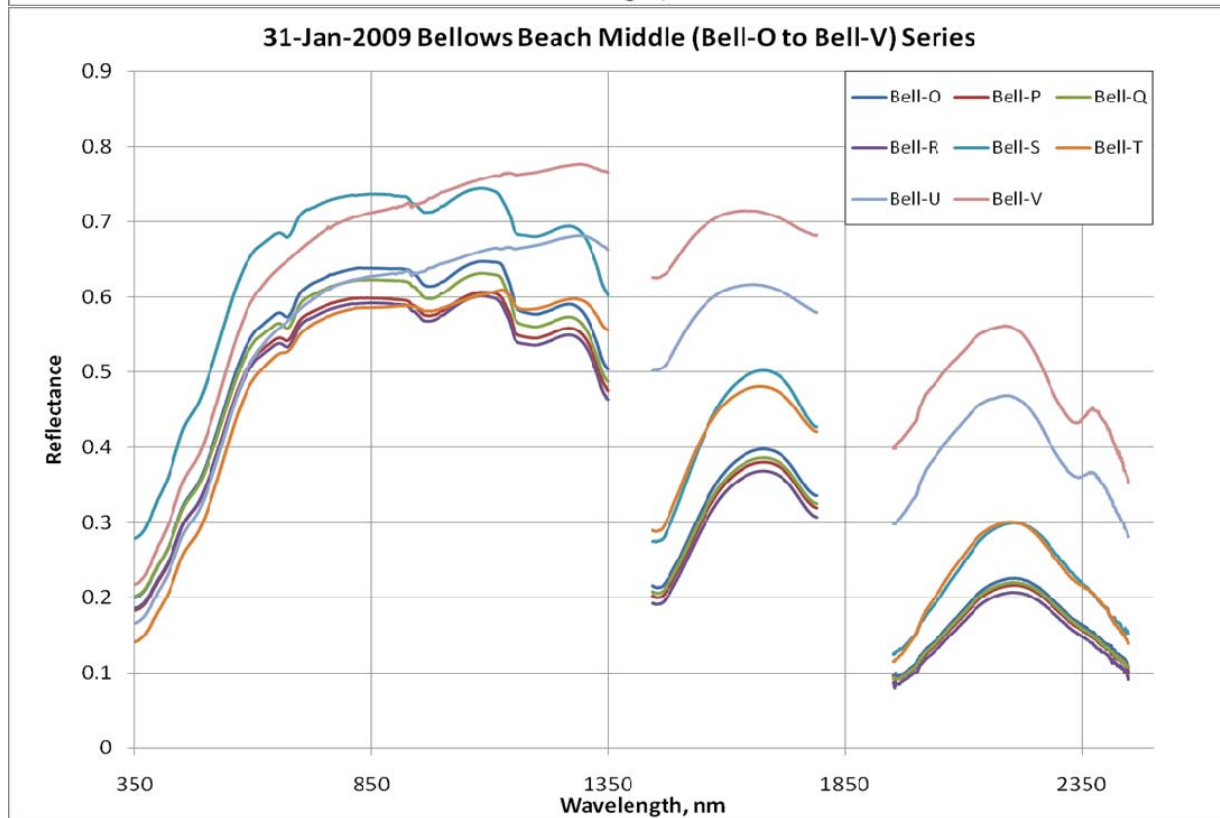
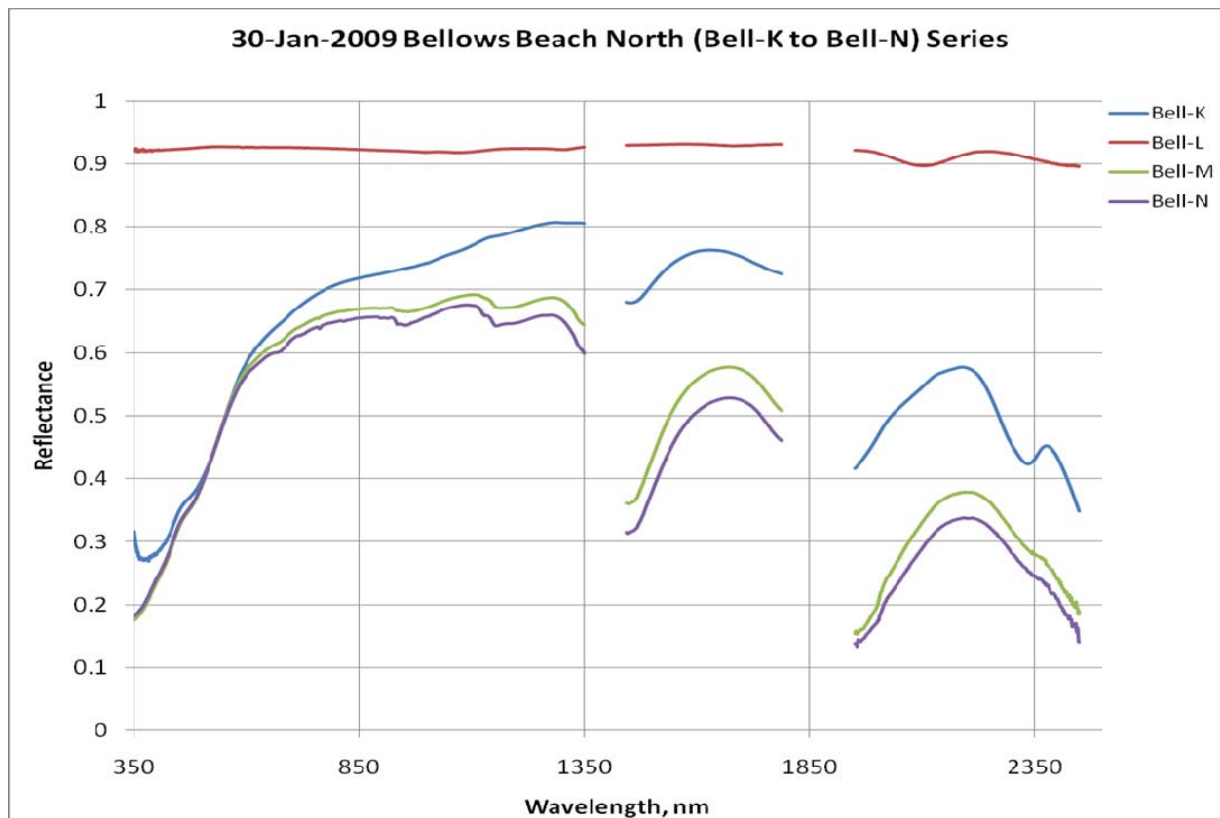
The majority of spectra were measured with Analytical Spectral Devices (ASD) portable field spectrometers covering the range from 0.35 to 2.5 μm . Spectra measured on the ASD spectrometer uses passive solar illumination and fiber-optic probe to collect light. The solar zenith incidence angle was variable but typically ranged from 40 to 60 degrees. Spectra are corrected to absolute reflectance by comparison against a Spectralon white reference standard. Field spectra have been collected under various sky conditions. Most are collected under optimum conditions of clear skies. Because of limited time for field work, some spectra have been collected under partly cloudy skies. Due to days with variable cloud conditions, a dual spectrometer method was employed which allowed simultaneous recording of the white reference and the specimen of interest. The spectra were edited to eliminate spectral regions that with very high atmospheric water vapor absorption; these regions have low digital number counts and ratios between the spectral response of the white plaque and the specimen are often unstable in these spectral regions. The regions of editing were roughly from 1.35 μm to 1.44 μm , 1.79 μm to 1.95 μm and 2.45 μm to 2.5 μm .

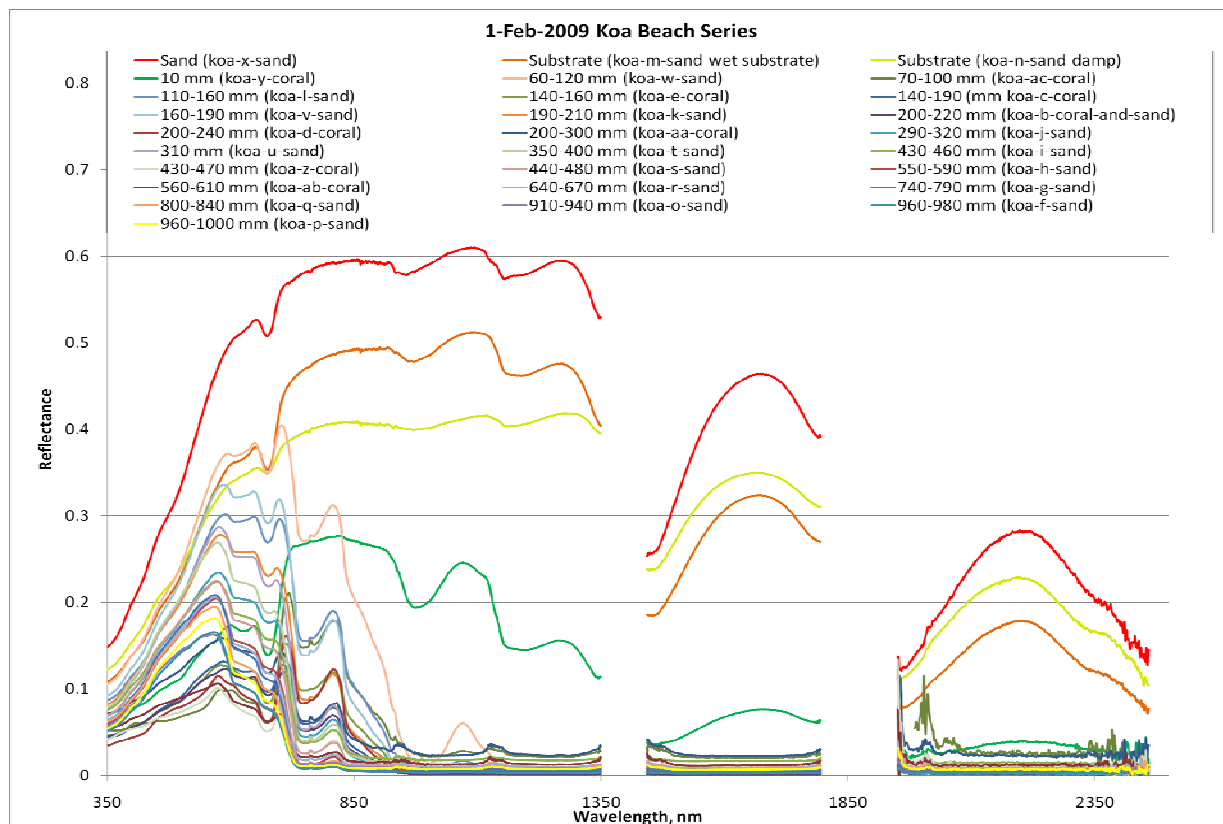
The digital spectral library data is a component of the geodatabase. The following graphs display the spectra as reflectance as a function of wavelength. Photographs of each spectra site are displayed below the graphs. The photographs are listed in alphabetical order by site name.

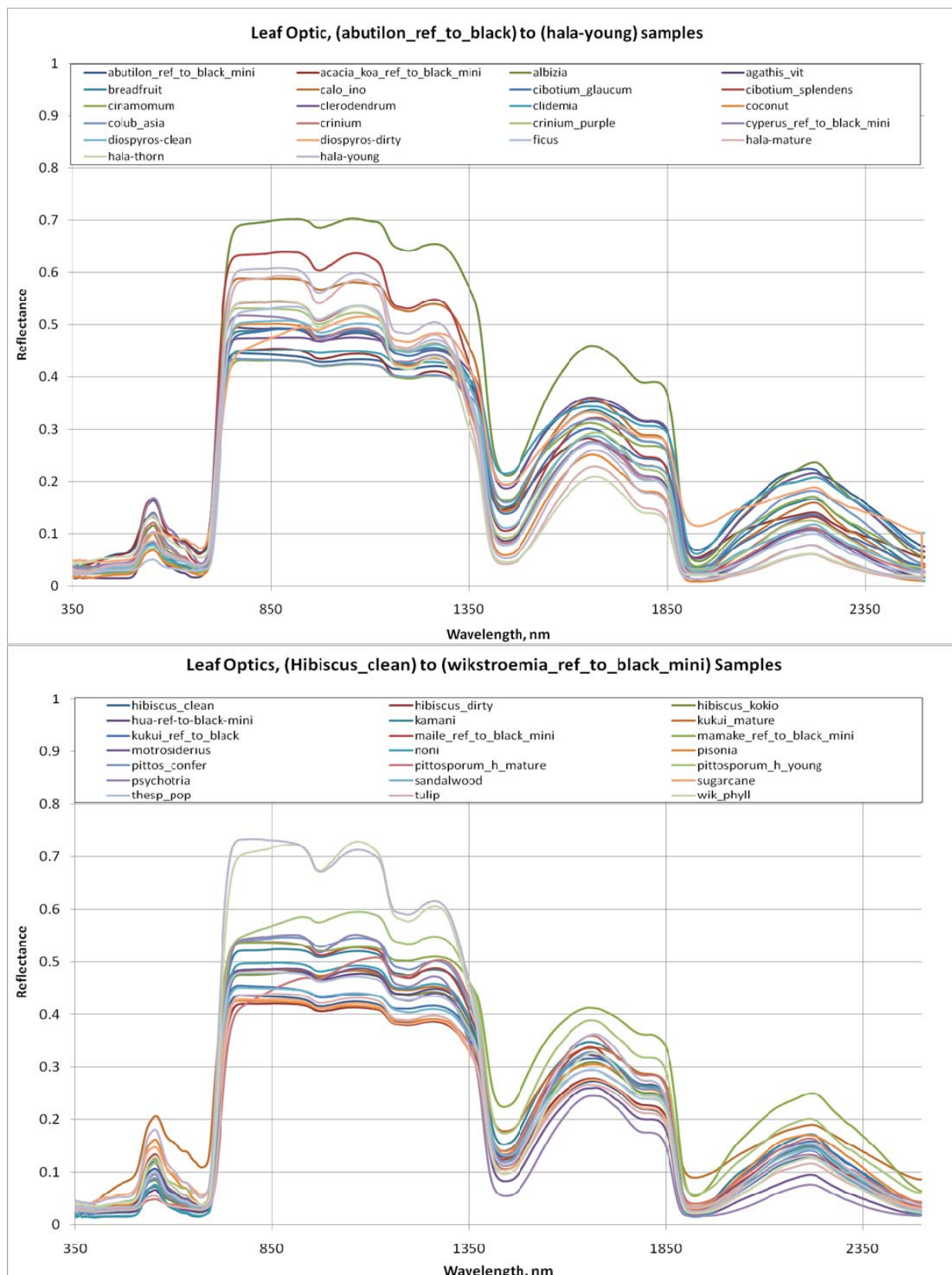
2. Reflectance Spectra







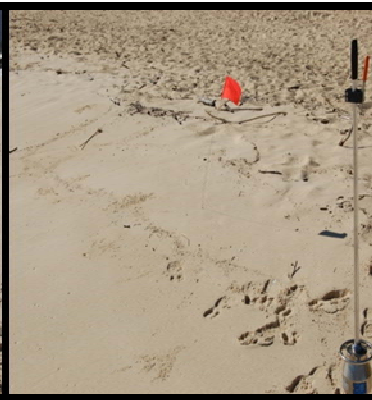




3. Site Photographs



Bellows-A



Bellows-B



Bellows-C



Bellows-D



Bellows-E



Bellows-F



Bellows-G



Bellows-H



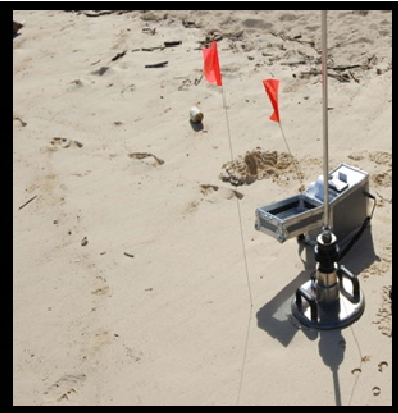
Bellows-I



Bellows-K



Bellows-L



Bellows-M



Bellows-N



Bellows-Q



Bellows-R



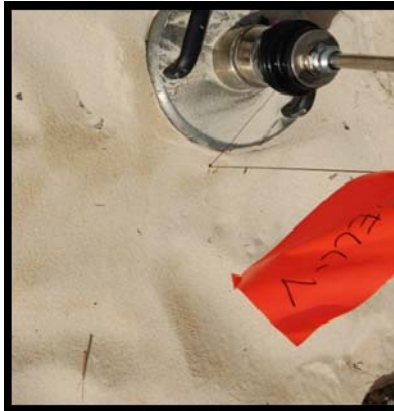
Bellows-S



Bellows-T



Bellows-U



Bellows-V



Hale-Koa Beach



P-01A



P-01B



P-01C



P-01D



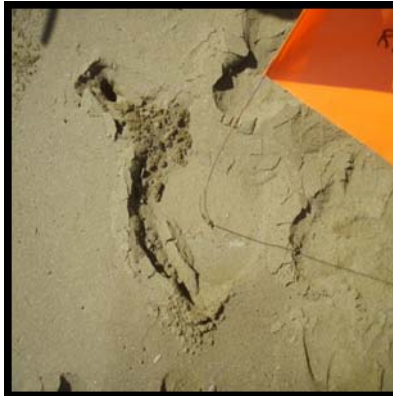
P-01E



RRB-01



RRB-02



RRB-03



RRP-01



RRP-02



RRP-03



RRP-04



RRP-05



RRP-06

APPENDIX F

Dynamic Modulus

1. Introduction

A Light Weight Deflectometer (LWD) is an instrument for measuring the dynamic deflection modulus. The LWD includes components such as a weight-fix-and-release mechanism, guide rod, falling weight, steel spring, and a base plate. Once the weight drops, the spring provides the buffer system that transmits the load pulse to the plate resting on the material to be tested. The weight is raised to a fixed height that, when dropped, will impart a standardized force pulse. Once the weight is dropped then the resulting vertical surface deflection is measured.

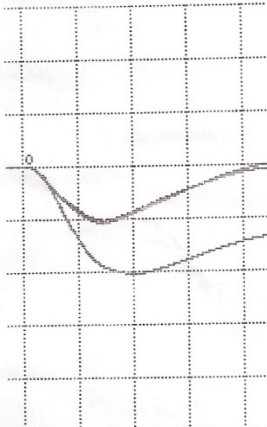
The Zorn ZFG 2000 LWD, with a 10-Kg (22.05 lbs) weight and a 300 mm (11.8 in) diameter plate was used to conduct plate-bearing tests during HIHARES'09. The LWD was used to measure bearing capacity (deflection), one of the two failure mechanisms of soil under load. It is highly portable and was easily transported around the coastal zone. The Zorn ZFG 2000 provides a simple way to estimate bearing capacity and the recorder/printer device gives hard copy results in the field as well as a means of recording data onto a chip card for uploading to a PC.

The LWD measures the in-situ dynamic modulus of soils. The influence depth is approximately 1 to 1.5 times the plate diameter. Hard copy results from HIHARES'09 are provided below:

2. LWD Graphs

23 JAN 2009

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 5.0 mm/cm t: 10ms/cm
Card: #020507151116/1
Fr 23.01.09 10:32:48

Nr.	v(mm/s)	s (mm)
1.	1032.3	10.262
2.	626.9	5.212
3.	660.9	5.469
i.M.	773.4	6.981

s/v= 9.026 ms
Evd= 3.2 MN/m²

Weather:

clouds
POI-A first pulse with

Project:

1st try

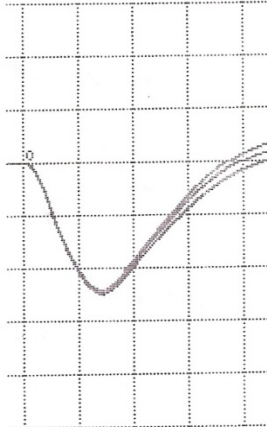
Plate base:

Pyramid Rock Beach
Testarea, -layer:

NRL-DC(7232)

Institute, operator:

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 2.0 mm/cm t: 10ms/cm
Card: #020507151116/2
Fr 23.01.09 10:41:16

Nr.	v(mm/s)	s (mm)
1.	606.6	5.011
2.	603.9	4.894
3.	607.2	4.976
i.M.	605.9	4.960

s/v= 8.186 ms

Evd= 4.5 MN/m²

Weather:

cloudy
POI-A 2nd try

Project:

Plate base:

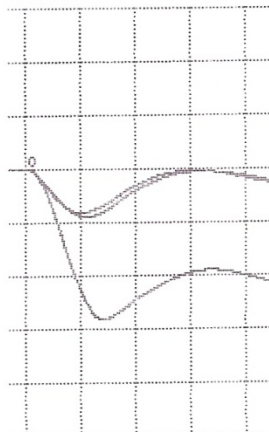
Pyramid Rock Beach
Testarea, -layer:

NRL-DC(7232)

Institute, operator:

30 Jan 2009

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 2.0 mm/cm t: 10ms/cm
Card: #020507151116/17
Fr 30.01.09 10:40:46

Nr.	v (mm/s)	s (mm)
1.	642.9	5.676
2.	260.6	1.829
3.	257.8	1.657
i.M.	387.1	3.054

s/v = 7.889 ms
Evd = 7.4 MN/m²

Weather: clear

Project: Bellow Beach

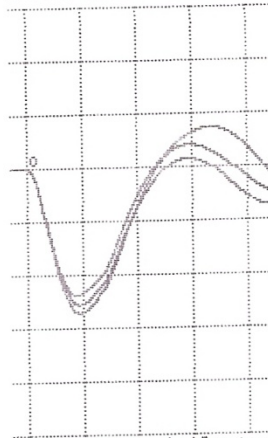
Plate base:

Testarea, -layer:

NRL-7232

Institute, operator:

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 0.5 mm/cm t: 10ms/cm
Card: #020507151116/18
Fr 30.01.09 10:42:02

Nr.	v (mm/s)	s (mm)
1.	240.7	1.367
2.	231.0	1.290
3.	231.2	1.204
i.M.	234.3	1.287

s/v = 5.493 ms
Evd = 17.5 MN/m²

Weather: clear

Project: Bellow Beach

Plate base:

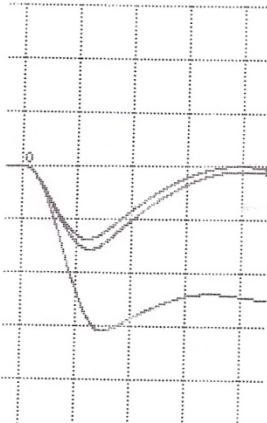
Testarea, -layer:

NRL-7232

Institute, operator:

23 JAN 2009

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 2.0 mm/cm t: 10ms/cm
Card: #020507151116/3
Fr 23.01.09 10:45:42

Nr.	v (mm/s)	s (mm)
1.	682.0	6.225
2.	405.1	3.179
3.	383.8	2.806
i.M.	490.3	4.070

s/v = 8.301 ms
Evd = 5.5 MN/m²

Weather: partly cloudy

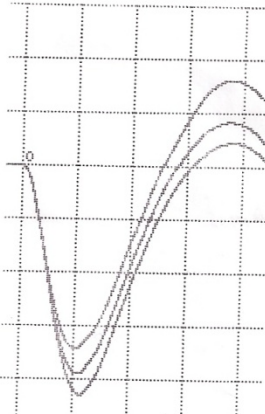
POI-B 128
Project: 2

Pyramid Rock Beach
Plate base:

Testarea, -layer:

NRL-DC (7232)
Institute, operator:

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 0.5 mm/cm t: 10ms/cm
Card: #020507151116/4
Fr 23.01.09 10:47:20

Nr.	v (mm/s)	s (mm)
1.	322.0	2.158
2.	305.1	1.957
3.	280.9	1.720
i.M.	302.7	1.945

s/v = 6.426 ms
Evd = 11.6 MN/m²

Weather: partly cloudy

POI-B 2400
Project: 2

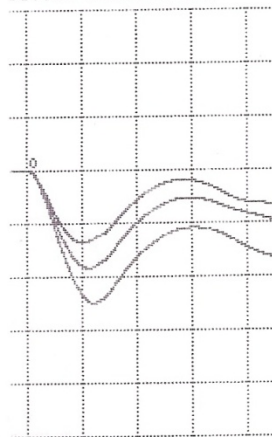
Pyramid Rock Beach
Plate base:

Testarea, -layer:

NRL-DC (7232)
Institute, operator:

23 Jan 2009

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 1.0 mm/cm t: 10ms/cm
Card: #020507151116/5
Fr 23.01.09 10:50:54

Nr.	v (mm/s)	s (mm)
1.	333.1	2.515
2.	277.1	1.858
3.	219.4	1.367
i.M.	276.5	1.913

s/v= 6.919 ms
Evd= 11.8 MN/m²

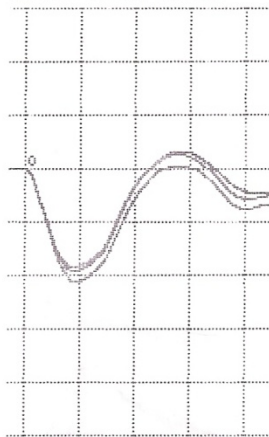
Weather: cloudy
V01-C 1st try

Project:
Coul pulse
not recorded

Plate base:
Pyramid Rock Beach
Testarea, -layer:

NRL-DC (7232)
Institute, operator:

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 0.5 mm/cm t: 10ms/cm
Card: #020507151116/6
Fr 23.01.09 10:53:08

Nr.	v (mm/s)	s (mm)
1.	193.3	1.072
2.	178.8	0.975
3.	177.8	0.939
i.M.	180.0	0.995

s/v= 5.528 ms
Evd= 22.6 MN/m²

Weather: cloudy
V01-C 2nd try

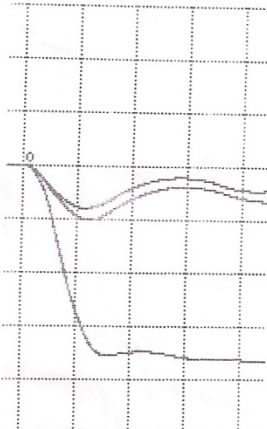
Project:

Plate base:
Pyramid Rock Beach
Testarea, -layer:

NRL-DC (7232)
Institute, operator:

23 JAN 2009

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 2.0 mm/cm t: 10ms/cm
Card: #020507151116/7
Fr 23.01.09 10:59:02

Nr.	v (mm/s)	s (mm)
1.	796.8	7.116
2.	271.7	2.074
3.	241.8	1.651
i.M.	436.8	3.614

s/v = 8.274 ms
Evd = 6.2 MN/m²

Weather: *clouds*
1st
CDI-D

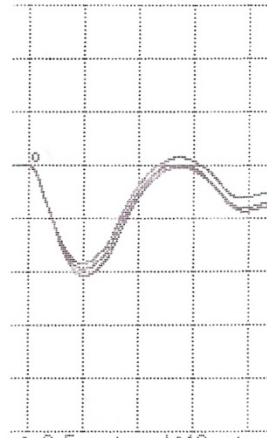
Project: *Pyramid Rock Beach*

Plate base:

Testarea, -layer:

Institute, operator:

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 0.5 mm/cm t: 10ms/cm
Card: #020507151116/8
Fr 23.01.09 11:02:50

Nr.	v (mm/s)	s (mm)
1.	168.0	1.045
2.	164.4	0.982
3.	161.2	0.929
i.M.	164.5	0.985

s/v = 5.988 ms *clouds*
Evd = 22.8 MN/m²

Weather: *1 pulse before*
unrecorded
2nd
POI-D

Project: *Pyramid Rock Beach*

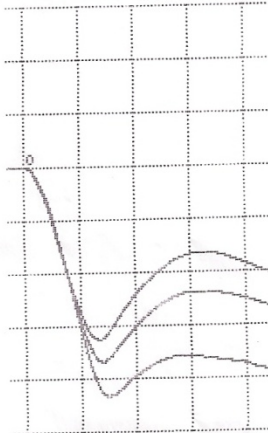
Plate base:

Testarea, -layer:

Institute, operator:

23 JAN 2009

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 1.0 mm/cm t: 10ms/cm
Card: #020507151116/9
Fr 23.01.09 11:09:28

Nr.	v (mm/s)	s (mm)
1.	457.7	4.351
2.	401.0	3.697
3.	363.7	3.278
i.M.	407.5	3.775

s/v= 9.264 ms
Evd= 6.0 MN/m²

Weather: Initial pulse not recorded

Project: POL-1st try

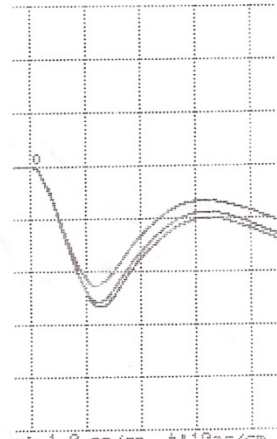
Pyramid rock beach

Plate base:

Testarea, -layer:

NRL-DC (7232)
Institute, operator:

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 1.0 mm/cm t: 10ms/cm
Card: #020507151116/10
Fr 23.01.09 11:11:36

Nr.	v (mm/s)	s (mm)
1.	322.6	2.691
2.	327.0	2.597
3.	305.5	2.290
i.M.	318.4	2.526

s/v= 7.933 ms
Evd= 8.9 MN/m²

Weather: P015 2nd try

Project: 1/25/09

Pyramid rock beach

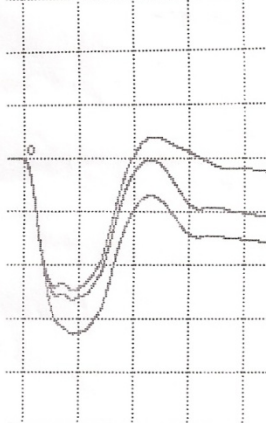
Plate base:

Testarea, -layer:

NRL-DC (7232)
Institute, operator:

24 Jan 2009

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 0.2 mm/cm t: 10ms/cm

Card: #020507151116/1

Sa 24.01.09 10:56:08

Nr.	v (mm/s)	s (mm)
1.	173.0	0.662
2.	162.5	0.532
3.	165.7	0.496
1.M.	167.1	0.563

s/v = 3.369 ms

Evd = 40.0 MN/m²

Weather: *first pulse not recorded*

RRDI first try

Project:

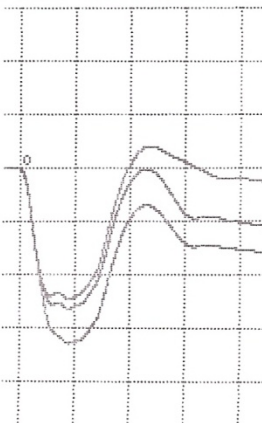
Plate base:

Testarea, -layer:

NRL-DC(7232)

Institute, operator:

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3875



s: 0.2 mm/cm t: 10ms/cm

Card: #020507151116/1

Sa 24.01.09 10:56:08

Nr.	v (mm/s)	s (mm)
1.	173.0	0.662
2.	162.5	0.532
3.	165.7	0.496
1.M.	167.1	0.563

s/v = 3.369 ms

Evd = 40.0 MN/m²

Weather:

RRDI 2nd try

Project:

Plate base:

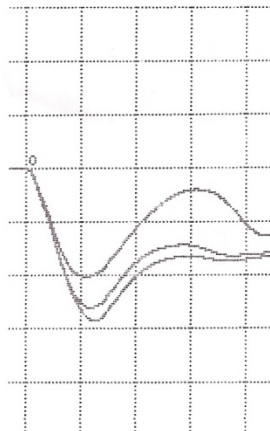
Testarea, -layer:

NRL-DC(7232)

Institute, operator:

24 JAN 2009

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3875



s: 0.5 mm/cm t: 10ms/cm
Card: #020507151116/2
Sa 24.01.09 11:13:52

Nr.	v(mm/s)	s (mm)
1.	186.5	1.432
2.	187.4	1.314
3.	164.9	1.028
i.M.	179.6	1.258

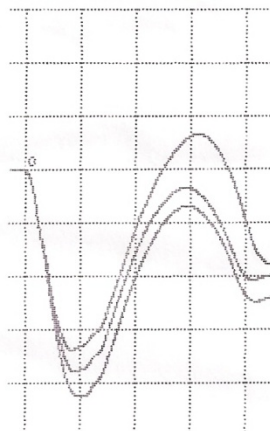
s/v= 7.004 ms
Evd= 17.9 MN/m² *1st pulse dropped*

Weather: *← 2-4*
RRB02-1st try
Project:

Plate base:
Testarea, -layer:

NRL-DC (7232)
Institute, operator:

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3875



s: 0.2 mm/cm t: 10ms/cm
Card: #020507151116/3
Sa 24.01.09 11:15:14

Nr.	v(mm/s)	s (mm)
1.	146.3	0.853
2.	136.1	0.757
3.	132.4	0.680
i.M.	138.3	0.763

s/v= 5.517 ms
Evd= 29.5 MN/m²

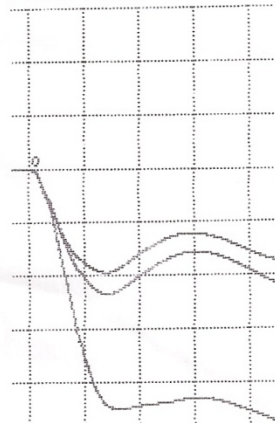
Weather: *one pulse dropped*
RRB02 2nd try
Project:

Plate base:
Testarea, -layer:

NRL-DC (7232)
Institute, operator:

24 JAN 2009

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 1.0 mm/cm t: 10ms/cm
Card: #020507151116/4
Sa 24.01.09 11:44:08

Nr.	v (mm/s)	s (mm)
1.	486.7	4.530
2.	303.8	2.376
3.	290.5	1.976
1.M.	357.0	2.961

s/v = 8.294 ms
Evd = 7.6 MN/m²

Weather:

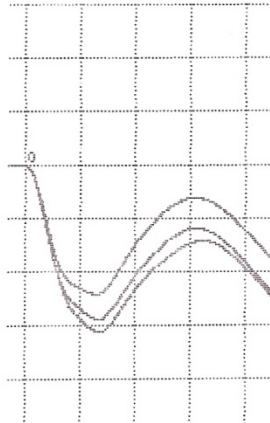
Project: RRBO3 - 54 try

Plate base:

Testarea, -layer:

Institute, operator: NRL-DC (7232)

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 0.5 mm/cm t: 10ms/cm
Card: #020507151116/5
Sa 24.01.09 11:45:22

Nr.	v (mm/s)	s (mm)
1.	239.2	1.572
2.	233.7	1.455
3.	209.1	1.214
1.M.	227.3	1.414

s/v = 6.221 ms
Evd = 15.9 MN/m²

Weather:

Project: RRBO3 - 2nd try

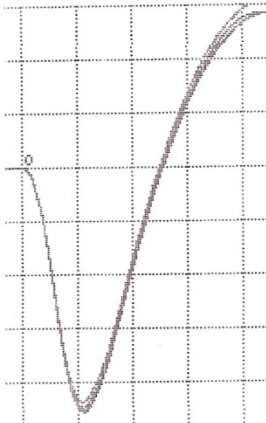
Plate base:

Testarea, -layer:

Institute, operator: NRL-DC (7232)

24 Jan 2009

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 1.0 mm/cm t: 10ms/cm
Card: #020507151116/7
Sa 24.01.09 13:36:10

Nr.	v (mm/s)	s (mm)
1.	700.7	4.579
2.	714.9	4.506
3.	700.5	4.392
i.M.	705.4	4.492

s/v = 6.368 ms

Evd = 5.0 MN/m²

Weather: 5 of 9 pulses
one not recorded

RRP01 - 2ndtg

Project:

Clear sky

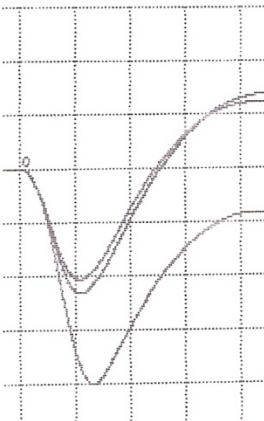
Plate base:

Testarea, -layer:

NRL-DC (7232)

Institute, operator:

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 2.0 mm/cm t: 10ms/cm
Card: #020507151116/6
Sa 24.01.09 13:34:06

Nr.	v (mm/s)	s (mm)
1.	1036.1	8.066
2.	651.4	4.178
3.	725.2	4.684
i.M.	804.2	5.643

s/v = 7.017 ms

Evd = 4.0 MN/m²

Weather: 1st pulse
double
bounced

RRP-01

Project:

Clear sky

Plate base:

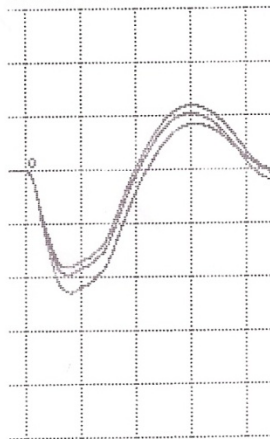
Testarea, -layer:

NRL-DC (7232)

Institute, operator:

24 Jan 2009

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 0.5 mm/cm t: 10ms/cm
Card: #020507151116/8
Sa 24.01.09 13:41:36

Nr.	v (mm/s)	s (mm)
1.	276.4	1.155
2.	249.1	0.989
3.	231.7	0.922
i.M.	252.4	1.022

s/v = 4.049 ms
Evd = 22.0 MN/m²

Weather: clear sky

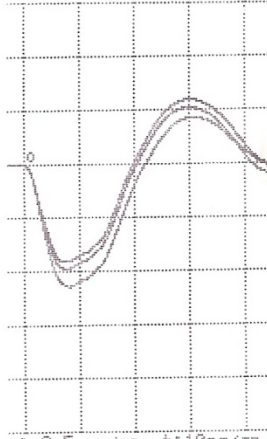
RRP03 - 1st try
Project:

Plate base:

Testarea, -layer:

NRL-DC (7232)
Institute, operator:

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 0.5 mm/cm t: 10ms/cm
Card: #020507151116/8
Sa 24.01.09 13:41:36

Nr.	v (mm/s)	s (mm)
1.	276.4	1.155
2.	249.1	0.989
3.	231.7	0.922
i.M.	252.4	1.022

s/v = 4.049 ms
Evd = 22.0 MN/m²

Weather: clear sky

RRP03 - 2nd try
Project:

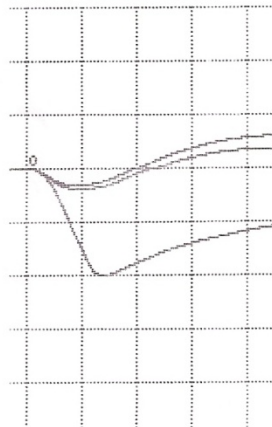
Plate base:

Testarea, -layer:

NRL-DC (7232)
Institute, operator:

24 Jan 2009

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 5.0 mm/cm t: 10ms/cm
Card: #020507151116/9
Sa 24.01.09 13:46:40

Nr.	v(mm/s)	s (mm)
1.	1192.9	10.149
2.	365.0	2.039
3.	344.0	1.683
1.M.	634.0	4.624

s/v= 7.293 ms
Evd= 4.9 MN/m²

Weather: clear sky

RRP02

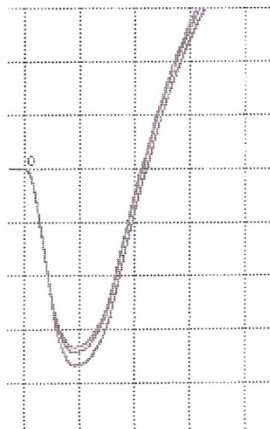
Project:

Plate base:

Testarea, -layer:

Institute, operator:

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 0.5 mm/cm t: 10ms/cm
Card: #020507151116/10
Sa 24.01.09 13:49:34

Nr.	v(mm/s)	s (mm)
1.	359.6	1.846
2.	351.8	1.725
3.	350.1	1.676
1.M.	353.8	1.749

s/v= 4.943 ms
Evd= 12.9 MN/m²

Weather: clear sky

RRP02

Project:

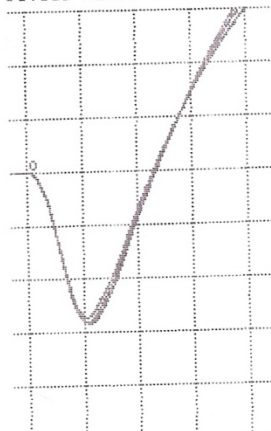
Plate base:

Testarea, -layer:

Institute, operator:

24 Jan 2009

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3875



s: 2.0 mm/cm t: 10ms/cm
Card: #020507151116/11
Sa 24.01.09 13:58:12

Nr.	v (mm/s)	s (mm)
1.	900.2	5.723
2.	925.2	5.674
3.	914.1	5.479
i.M.	913.2	5.625

s/v= 6.160 ms

Evd= 4.0 MN/m²

Weather: 1st print not recorded - double exposure

RRP05 - 1st try

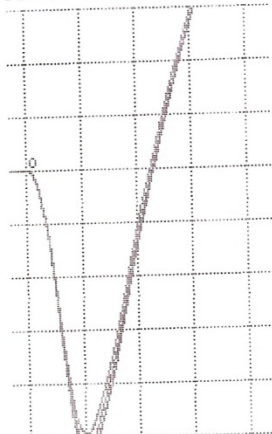
Project: low vegetation cover

Plate base:

Testarea: -layer:

NRL-DC (7232)
Institute, operator:

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3875



s: 1.0 mm/cm t: 10ms/cm
Card: #020507151116/12
Sa 24.01.09 14:00:08

Nr.	v (mm/s)	s (mm)
1.	846.4	4.970
2.	890.8	5.244
3.	910.7	5.466
i.M.	882.6	5.227

s/v= 5.922 ms

Evd= 4.3 MN/m²

Weather: clear sky

RRP05 - 2nd try

Project:

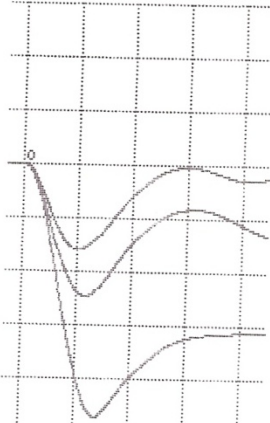
Plate base:

Testarea: -layer:

NRL-DC (7232)
Institute, operator:

30 Jan 2009

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 1.0 mm/cm t: 10ms/cm
Card: #020507151116/13
Fr 30.01.09 09:50:28

Nr.	v (mm/s)	s (mm)
1.	534.4	4.754
2.	340.6	2.478
3.	256.8	1.601
i.M.	377.3	2.944

s/v = 7.803 ms
Evd = 7.6 MN/m²

Weather: partly cloudy

Bellow Beach

Project:

30 Jan 09

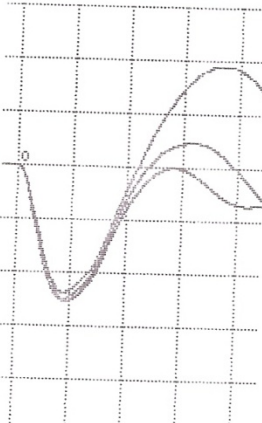
Plate base:

Testarea: -layer:

NRL-DC (17232)

Institute, operator:

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 0.5 mm/cm t: 10ms/cm
Card: #020507151116/14
Fr 30.01.09 09:52:18

Nr.	v (mm/s)	s (mm)
1.	214.7	1.278
2.	235.6	1.198
3.	268.2	1.265
i.M.	239.5	1.247

s/v = 5.207 ms
Evd = 18.0 MN/m²

Weather: partly cloudy

Bellow Beach

Project:

30 Jan 09

Plate base:

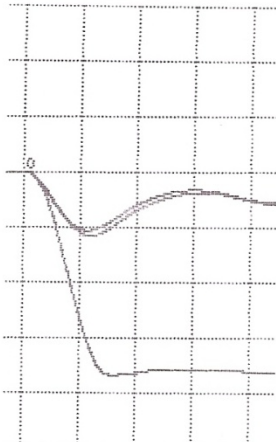
Testarea: -layer:

NRL-DC (17232)

Institute, operator:

30 Jan 2009

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 2.0 mm/cm t: 10ms/cm
Card: #020507151116/15
Fr 30.01.09 10:19:50

Nr.	v (mm/s)	s (mm)
1.	793.0	7.398
2.	315.6	2.361
3.	315.7	2.169
i.M.	474.8	3.976

s/v= 8.374 ms
Evd= 5.7 MN/m²

Weather: clear

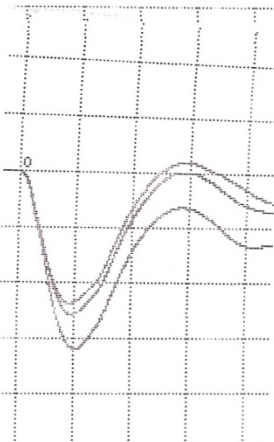
Bellow Beach
Project:

Plate base:

Testarea, -layer:

NRL-DC (7232)
Institute, operator:

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 0.5 mm/cm t: 10ms/cm
Card: #020507151116/16
Fr 30.01.09 10:21:06

Nr.	v (mm/s)	s (mm)
1.	254.9	1.603
2.	215.3	1.296
3.	207.7	1.196
i.M.	226.0	1.365

s/v= 6.040 ms
Evd= 16.5 MN/m²

Weather: clear

Bellow Beach
Project:

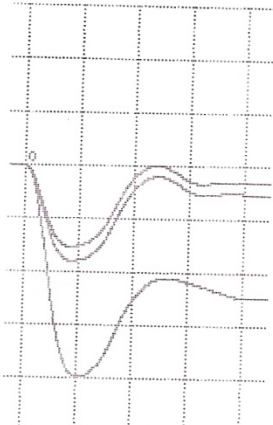
Plate base:

Testarea, -layer:

NRL-DC (7232)
Institute, operator:

31 JAN 2009

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 0.5 mm/cm t: 10ms/cm
Card: #020507151116/5
Sa 31.01.09 10:56:58

Nr.	v (mm/s)	s (mm)
1.	354.1	1.997
2.	188.5	0.914
3.	168.1	0.781
i.M.	236.9	1.231

s/v = 5.196 ms
Evd = 18.3 MN/m²

Weather:

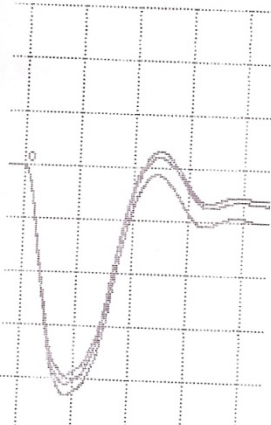
Project:

Plate base:

Testarea, -layer:

NRL-7232
Institute, operator:

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 0.2 mm/cm t: 10ms/cm
Card: #020507151116/6
Sa 31.01.09 10:59:10

Nr.	v (mm/s)	s (mm)
1.	189.8	0.867
2.	184.4	0.825
3.	180.1	0.794
i.M.	184.8	0.829

s/v = 4.486 ms
Evd = 27.1 MN/m²

Weather:

Project:

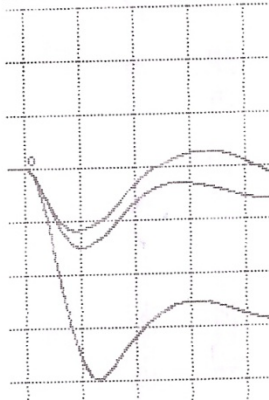
Plate base:

Testarea, -layer:

NRL-7232
Institute, operator:

30 Jan 2009

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 1.0 mm/cm t: 10ms/cm
Card: #020507151116/19
Fr 30.01.09 10:55:44

Nr.	v(mm/s)	s (mm)
1.	511.3	4.000
2.	239.5	1.514
3.	241.3	1.197
i.M.	330.7	2.237

s/v= 6.764 ms
Evd= 10.1 MN/m²

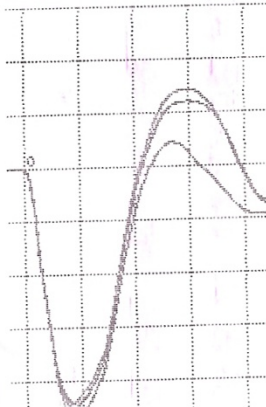
Weather: *clear*
Bellow Beach
Project:

Plate base:

Testarea, -layer:

NRL-7232
Institute, operator:

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 0.2 mm/cm t: 10ms/cm
Card: #020507151116/20
Fr 30.01.09 10:57:10

Nr.	v(mm/s)	s (mm)
1.	212.1	0.952
2.	206.8	0.911
3.	223.2	0.887
i.M.	214.0	0.917

s/v= 4.285 ms
Evd= 24.5 MN/m²

Weather: *clear*
Bellow Beach
Project:

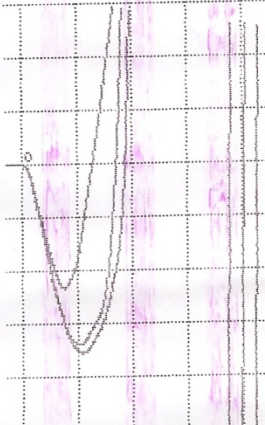
Plate base:

Testarea, -layer:

NRL-7232
Institute, operator:

30 Jan 2009

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 0.5 mm/cm t: 10ms/cm
Card: #020507151116/22
Fr 30.01.09 11:18:44

Nr.	v(mm/s)	s (mm)
1.	270.0	1.791
2.	267.7	1.703
3.	240.6	1.173
i.M.	259.4	1.556

s/v= 5.998 ms
Evd= 14.5 MN/m²

Weather:

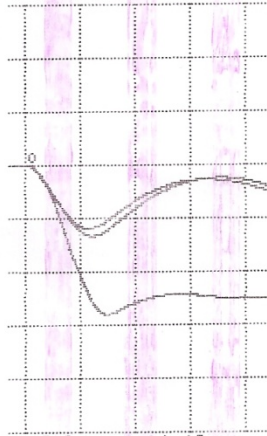
Project: Bellows Beach

Plate base:

Testarea, -layer:

NRL-7232
Institute, operator:

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 2.0 mm/cm t: 10ms/cm
Card: #020507151116/23
Fr 30.01.09 11:17:56

Nr.	v(mm/s)	s (mm)
1.	598.0	5.627
2.	348.9	2.699
3.	338.6	2.426
i.M.	425.8	3.584

s/v= 8.417 ms
Evd= 6.3 MN/m²

Weather:

Project: Bell I
2nd pos.
1st try

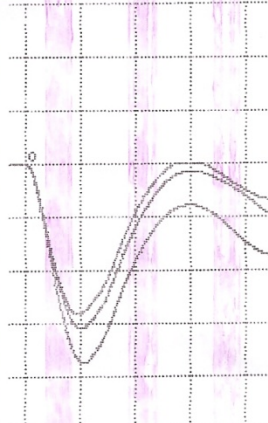
Plate base:

Testarea, -layer:

NRL-7232
Institute, operator:

30 JAN 2009

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 0.5 mm/cm t: 10ms/cm
Card: #020507151116/24
Fr 30.01.09 11:20:26

Nr.	v (mm/s)	s (mm)
1.	279.5	1.881
2.	246.9	1.555
3.	248.6	1.415
i.M.	258.3	1.617

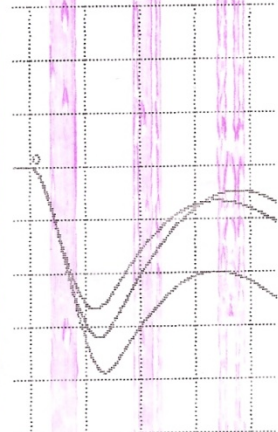
s/v= 6.260 ms
Evd= 13.9 MN/m²

Weather: Bell-I
Project: 2nd pass, 2nd try

Plate base:
Testarea, -layer:

NRL-7232
Institute, operator:

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 1.0 mm/cm t: 10ms/cm
Card: #020507151116/25
Fr 30.01.09 11:23:28

Nr.	v (mm/s)	s (mm)
1.	430.7	3.890
2.	397.6	3.219
3.	364.0	2.688
i.M.	397.4	3.266

s/v= 8.218 ms
Evd= 6.9 MN/m²

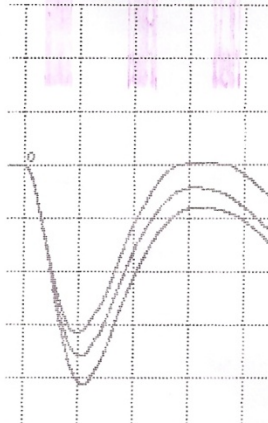
Weather: 2nd pass, 2nd try
Project: 2nd pass, 2nd try

Plate base:
Testarea, -layer:

NRL-7232
Institute, operator:

30 JAN 2009

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 0.5 mm/cm t: 10ms/cm
Card: #020507151116/26
Fr 30.01.09 11:25:16

Nr.	v (mm/s)	s (mm)
1.	384.6	2.072
2.	282.0	1.805
3.	262.2	1.583
1.M.	282.9	1.820

s/v = 6.433 ms
Evd = 12.4 MN/m²

Weather:

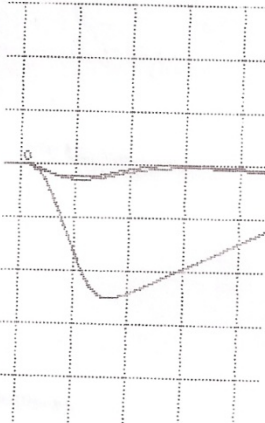
Project:

Plate base:

Testarea, -layer:

NRL-7232
Institute, operator:

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 5.0 mm/cm t: 10ms/cm
Card: #020507151116/27
Fr 30.01.09 11:29:12

Nr.	v (mm/s)	s (mm)
1.	1389.9	12.673
2.	243.3	1.584
3.	247.1	1.344
1.M.	626.8	5.200

s/v = 8.296 ms
Evd = 4.3 MN/m²

Weather:

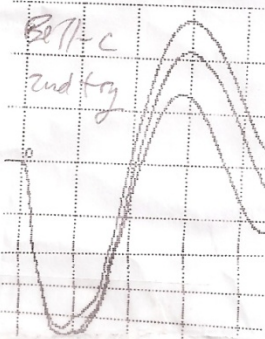
Project:

Plate base:

Testarea, -layer:

NRL-7232
Institute, operator:

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 5.0 mm/cm t: 10ms/cm
Card: #020507151116/28
Fr 30.01.09 11:31:12

Nr.	v (mm/s)	s (mm)
1.	213.2	0.945
2.	235.5	0.927
3.	229.5	0.862
1.M.	226.1	0.911

s/v = 4.029 ms
Evd = 24.7 MN/m²

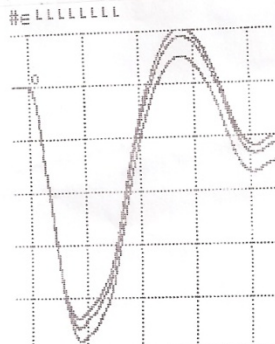
Weather:

Bellows
Beach

NRL-7232

30 JAN 2009

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 0.2 mm/cm t: 10ms/cm
Card: #020507151116/31
Fr 30.01.09 11:48:30

Nr.	v (mm/s)	s (mm)
1.	174.1	0.964
2.	184.7	0.916
3.	182.6	0.883
i.M.	180.5	0.921

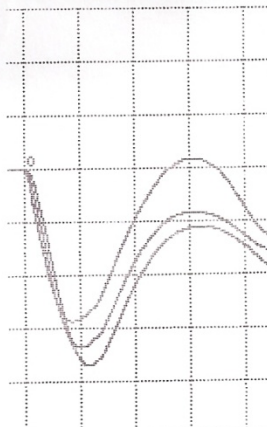
s/v = 5.102 ms
Evd = 24.4 MN/m²

Weather: bell-c
3rd try
Project:

Plate base:

Testarea, -layer:

NRL-7232
Institute, operator:



s: 0.5 mm/cm t: 10ms/cm
Card: #020507151116/32
Fr 30.01.09 12:08:54

Nr.	v (mm/s)	s (mm)
1.	271.5	1.865
2.	276.6	1.692
3.	315.2	1.443
i.M.	287.8	1.667

s/v = 5.792 ms
Evd = 13.5 MN/m²

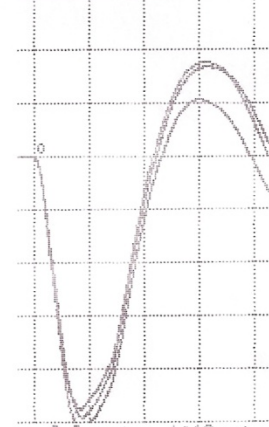
Weather: Bell-J
Project: Rigt try

Plate base:

Testarea, -layer:

NRL-7232
Institute, operator:

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 0.2 mm/cm t: 10ms/cm
Card: #020507151116/33
Fr 30.01.09 12:11:18

Nr.	v (mm/s)	s (mm)
1.	191.7	0.984
2.	213.4	1.036
3.	204.6	0.953
i.M.	203.2	0.991

s/v = 4.877 ms
Evd = 22.7 MN/m²

Weather: Bell-J
Project: 2nd try

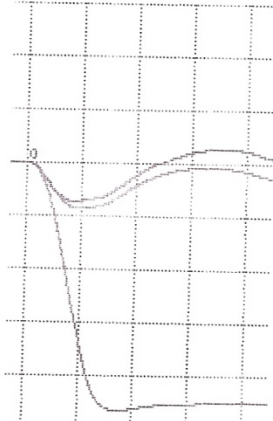
Plate base:

Testarea, -layer:

NRL 7232
Institute, operator:

30 JAN 2009

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 2.0 mm/cm t: 10ms/cm
Card: #020507151116/34
Fr 30.01.09 12:15:30

Nr.	v (mm/s)	s (mm)
1.	1058.4	9.348
2.	295.9	1.768
3.	302.2	1.504
1.M.	552.2	4.207

s/v = 7.619 ms
Evd = 5.3 MN/m²

Weather:

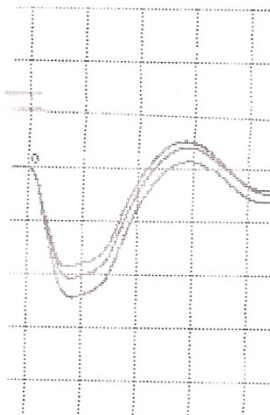
Belows Beach
Project:

Plate base:

BELLD
Testarea, -layer:

NRL-7232
Institute, operator:

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 0.5 mm/cm t: 10ms/cm
Card: #020507151116/35
Fr 30.01.09 12:17:04

Nr.	v (mm/s)	s (mm)
1.	278.1	1.230
2.	238.9	1.052
3.	228.2	0.942
1.M.	248.4	1.075

s/v = 4.328 ms
Evd = 20.9 MN/m²

Weather:

Belows Beach
Project:

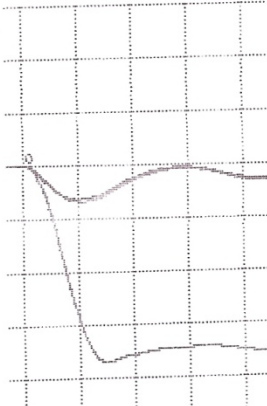
Plate base:

BELLD
Testarea, -layer:

NRL-7232
Institute, operator:

30 Jan 2009

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 2.0 mm/cm t: 10ms/cm
Card: #020507151116/36
Fr 30.01.09 12:21:16

Nr.	v (mm/s)	s (mm)
1.	851.7	7.438
2.	215.4	1.392
3.	217.0	1.310
i.M.	428.0	3.380

s/v = 7.897 ms
Evd = 6.7 MN/m²

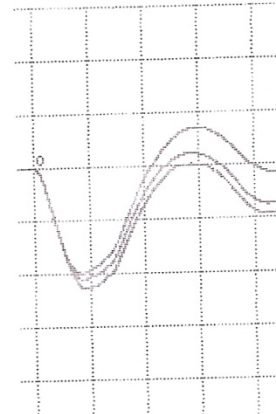
Weather:

Bellow Beach
Project:

Plate base:
BELL F
Testarea: -layer:
1

NRL-7232
Institute, operator:

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 0.5 mm/cm t: 10ms/cm
Card: #020507151116/37
Fr 30.01.09 12:22:42

Nr.	v (mm/s)	s (mm)
1.	197.6	1.146
2.	199.7	1.064
3.	213.3	1.006
i.M.	203.5	1.072

s/v = 5.268 ms
Evd = 21.0 MN/m²

Weather:

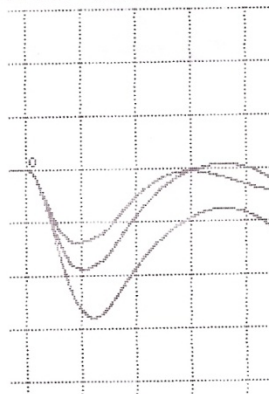
Bellow Beach
Project:

Plate base:
BELL F
Testarea: -layer:
2

NRL-7232
Institute, operator:

30 Jan 2009

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 1.0 mm/cm t: 10ms/cm
Card: #020507151116/38
Fr 30.01.09 12:26:08

Nr.	v (mm/s)	s (mm)
1.	386.5	2.814
2.	308.1	1.896
3.	261.5	1.401
1.M.	318.7	2.037

s/v = 6.392 ms
Evd = 11.0 MN/m²

Weather:

Project:

Plate base:

BECC

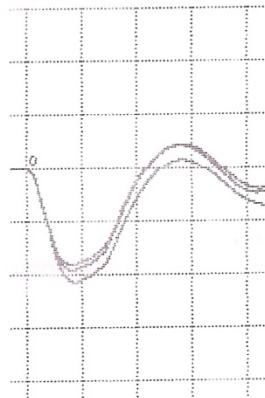
Testarea: -layer:

1

NRL-7232

Institute, operator:

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 0.5 mm/cm t: 10ms/cm
Card: #020507151116/39
Fr 30.01.09 12:28:40

Nr.	v (mm/s)	s (mm)
1.	214.3	1.082
2.	212.4	0.971
3.	203.2	0.921
1.M.	210.0	0.991

s/v = 4.719 ms
Evd = 22.7 MN/m²

Weather:

Project:

Plate base:

BECC -2

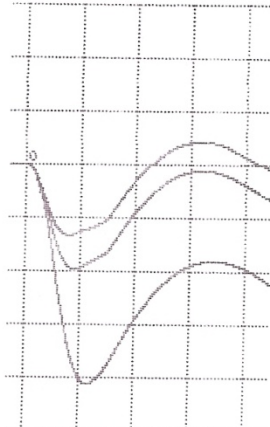
Testarea: -layer:

NRL-7232

Institute, operator:

30 JAN 2009

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 1.0 mm/cm t: 10ms/cm
Card: #020507151116/40
Fr 30.01.09 14:27:26

Nr.	v (mm/s)	s (mm)
1.	642.1	4.147
2.	377.5	1.991
3.	296.2	1.358
i.M.	438.6	2.499

s/v= 5.698 ms
Evd= 9.0 MN/m²

Weather:

Project:

Plate base:

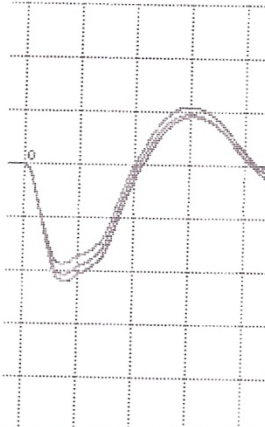
BELL-K 1

Testarea, -layer:

NRL-7232

Institute, operator:

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 0.5 mm/cm t: 10ms/cm
Card: #020507151116/41
Fr 30.01.09 14:29:54

Nr.	v (mm/s)	s (mm)
1.	258.7	1.111
2.	253.6	1.043
3.	238.8	0.943
i.M.	250.4	1.032

s/v= 4.121 ms
Evd= 21.8 MN/m²

Weather:

Project:

Plate base:

BELL-K 2

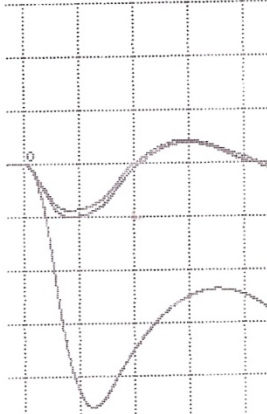
Testarea, -layer:

NRL-7232

Institute, operator:

30 Jan 2009

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 1.0 mm/cm t: 10ms/cm
Card: #020507151116/42
Fr 30.01.09 15:03:08

Nr.	v (mm/s)	s (mm)
1.	669.6	4.590
2.	220.0	1.030
3.	204.2	0.904
i.M.	371.3	2.175

s/v= 5.858 ms
Evd= 10.3 MN/m²

Weather:

Project:

Plate base:

BEU L 4m

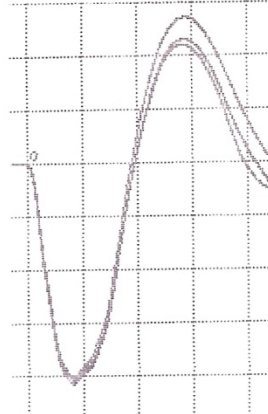
Testarea, -layer:

1

NRL-7232

Institute, operator:

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 0.2 mm/cm t: 10ms/cm
Card: #020507151116/43
Fr 30.01.09 15:04:46

Nr.	v (mm/s)	s (mm)
1.	202.3	0.809
2.	202.2	0.831
3.	198.8	0.817
i.M.	201.1	0.819

s/v= 4.073 ms
Evd= 27.5 MN/m²

Weather:

Project:

Plate base:

BEU L 4m

Testarea, -layer:

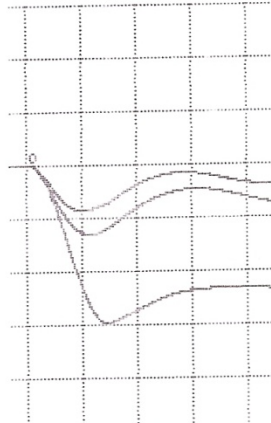
2

NRL-7232

Institute, operator:

30 Jan 2009

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 2.0 mm/cm t: 10ms/cm
Card: #020507151116/44
Fr 30.01.09 15:18:04

Nr.	v (mm/s)	s (mm)
1.	672.4	5.971
2.	401.1	2.680
3.	291.7	1.762
i.M.	455.1	3.471

s/v = 7.627 ms
Evd = 6.5 MN/m²

Weather:

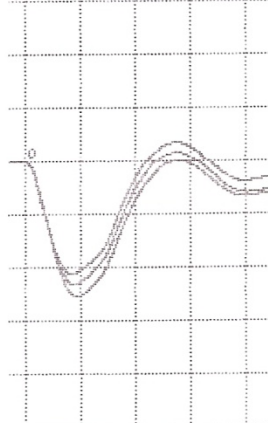
Project:

Plate base:

BELL-N 1
Testarea: -layer:

NRL-7232
Institute, operator:

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 0.5 mm/cm t: 10ms/cm
Card: #020507151116/45
Fr 30.01.09 15:19:16

Nr.	v (mm/s)	s (mm)
1.	219.5	1.283
2.	216.8	1.167
3.	213.8	1.071
i.M.	216.7	1.174

s/v = 5.418 ms
Evd = 19.2 MN/m²

Weather:

Project:

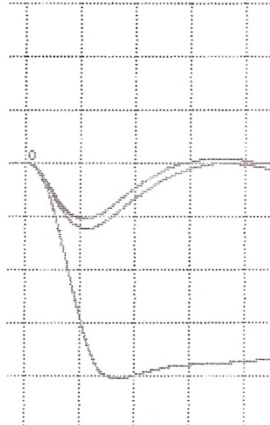
Plate base:

BELL-N 2
Testarea: -layer:

NRL-7232
Institute, operator:

30 JAN 2009

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 2.0 mm/cm t: 10ms/cm
Card: #020507151116/46
Fr 30.01.09 15:27:40

Nr.	v (mm/s)	s (mm)
1.	900.2	8.140
2.	381.2	2.519
3.	350.2	2.139
1.M.	543.9	4.266

s/v= 7.843 ms
Evd= 5.3 MN/m²

Weather:

Project:

Plate base:

BELN-1

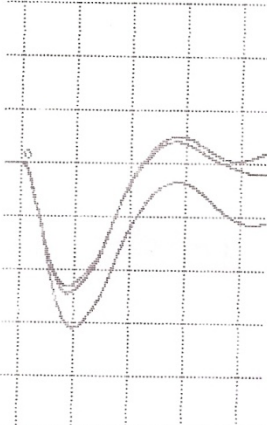
Testarea, -layer:

AFTER
WETTING

Institute, operator:

NRL-723Z

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 0.5 mm/cm t: 10ms/cm
Card: #020507151116/47
Fr 30.01.09 15:28:54

Nr.	v (mm/s)	s (mm)
1.	261.9	1.558
2.	223.7	1.230
3.	229.0	1.172
1.M.	238.2	1.320

s/v= 5.542 ms
Evd= 17.0 MN/m²

Weather:

Project:

Plate base:

BELN-1

Testarea, -layer:

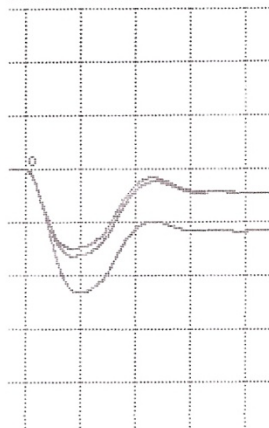
AFTER
WETTING

Institute, operator:

NRL-723Z

31 JAN 09

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 0.5 mm/cm t: 10ms/cm

Card: #020507151116/1

Sa 31.01.09 10:15:16

Nr.	v (mm/s)	s (mm)
1.	204.1	1.163
2.	168.4	0.831
3.	162.5	0.761
i.M.	178.3	0.918

s/v= 5.149 ms

Evd= 24.5 MN/m²

Weather: clear

Project:

Plate base:

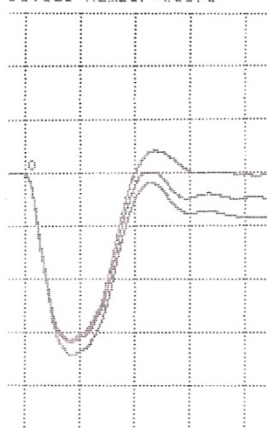
BEL2-0 1

Testarea, -layer:

NRL-7232

Institute, operator:

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 0.2 mm/cm t: 10ms/cm

Card: #020507151116/2

Sa 31.01.09 10:16:44

Nr.	v (mm/s)	s (mm)
1.	152.3	0.690
2.	149.0	0.644
3.	164.5	0.633
i.M.	155.3	0.656

s/v= 4.224 ms

Evd= 34.3 MN/m²

Weather: clear

Project:

Plate base:

BEL2-0 2

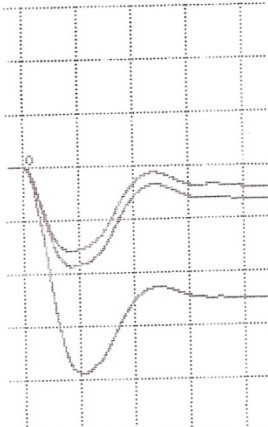
Testarea, -layer:

NRL-7232

Institute, operator:

31 JAN 2009

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 0.5 mm/cm t: 10ms/cm
Card: #020507151116/3
Sa 31.01.09 10:35:58

Nr.	v (mm/s)	s (mm)
1.	328.1	1.948
2.	183.0	0.943
3.	169.3	0.801
i.M.	226.8	1.231

s/v = 5.428 ms
Evd = 18.3 MN/m²

Weather: clear

Project:

Plate base:

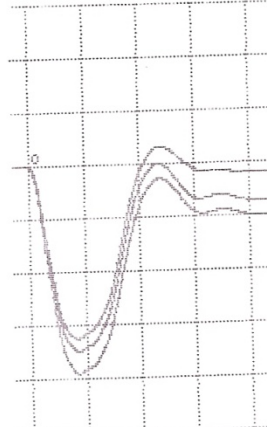
DELLP

Testarea, -layer: 1

NRL-7232

Institute, operator:

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 0.2 mm/cm t: 10ms/cm
Card: #020507151116/4
Sa 31.01.09 10:37:29

Nr.	v (mm/s)	s (mm)
1.	171.8	0.786
2.	156.1	0.704
3.	150.1	0.656
i.M.	159.3	0.715

s/v = 4.488 ms
Evd = 31.5 MN/m²

Weather: clear

Project:

Plate base:

DELLP2

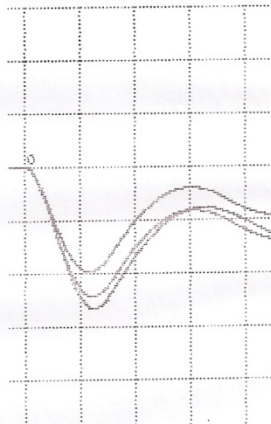
Testarea, -layer:

NRL-7232

Institute, operator:

31 Jan 2009

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 1.0 mm/cm t: 10ms/cm
Card: #020507151116/15
Sa 31.01.09 13:48:50

Nr.	v (mm/s)	s (mm)
1.	335.4	2.677
2.	327.3	2.454
3.	284.6	1.996
1.M.	315.8	2.376

s/v = 7.524 ms
Evd = 9.5 MN/m²

Weather:

Project:

Plate base:

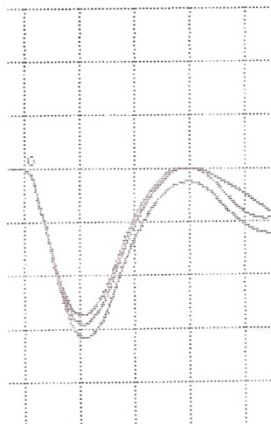
BELL-V 1

Testarea, -layer:

NRL 7232

Institute, operator:

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 0.5 mm/cm t: 10ms/cm
Card: #020507151116/16
Sa 31.01.09 13:51:00

Nr.	v (mm/s)	s (mm)
1.	239.1	1.590
2.	226.9	1.462
3.	216.9	1.375
1.M.	227.6	1.476

s/v = 6.485 ms
Evd = 15.2 MN/m²

Weather:

Project:

Plate base:

BELL-V-2

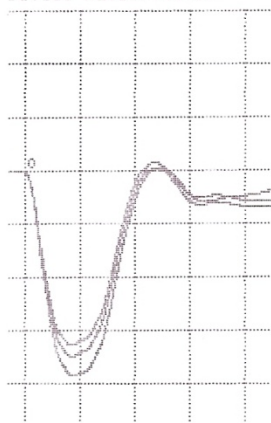
Testarea, -layer:

NRL-7232

Institute, operator:

31 Jan 2009

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 0.2 mm/cm t: 10ms/cm
Card: #020507151116/7
Sa 31.01.09 11:04:58

Nr.	v (mm/s)	s (mm)
1.	174.4	0.776
2.	161.4	0.703
3.	153.1	0.659
1.M.	163.0	0.713

s/v= 4.374 ms
Evd= 31.6 MN/m²

Weather:

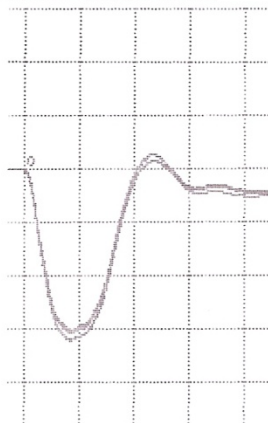
Project:

Plate base:

Testarea, -layer:

NRL-7232
Institute, operator:

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 0.2 mm/cm t: 10ms/cm
Card: #020507151116/8
Sa 31.01.09 11:06:58

Nr.	v (mm/s)	s (mm)
1.	151.3	0.647
2.	146.8	0.619
3.	144.8	0.609
1.M.	147.6	0.625

s/v= 4.234 ms
Evd= 36.0 MN/m²

Weather:

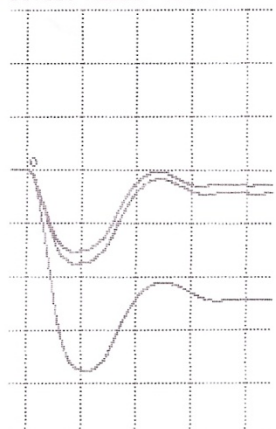
Project:

Plate base:

Testarea, -layer:

NRL-7232
Institute, operator:

DYN. PLATE LOADING TEST
 LIGHT DROP-WEIGHT TESTER
 TP BF-StB Teil B 8.3
 Instrument: ZORN ZFG-2000
 Device type: 300mm/10kg
 Device number: #3876



s: 0.5 mm/cm t: 10ms/cm
 Card: #020507151116/9
 Sa 31.01.09 11:09:46

Nr.	v (mm/s)	s (mm)
1.	337.3	1.894
2.	185.7	0.890
3.	168.0	0.777
i.M.	230.3	1.187

s/v= 5.154 ms
 Evd= 19.0 MN/m²

Weather:

Project: Bell-S 1st try

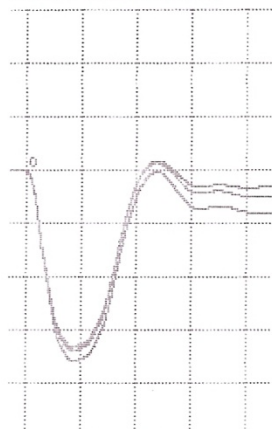
Plate base:

Testarea, -layer:

NRL-7232
 Institute, operator:

31 Jan 09

DYN. PLATE LOADING TEST
 LIGHT DROP-WEIGHT TESTER
 TP BF-StB Teil B 8.3
 Instrument: ZORN ZFG-2000
 Device type: 300mm/10kg
 Device number: #3876



s: 0.2 mm/cm t: 10ms/cm
 Card: #020507151116/10
 Sa 31.01.09 11:11:18

Nr.	v (mm/s)	s (mm)
1.	158.4	0.721
2.	153.3	0.684
3.	151.6	0.669
i.M.	154.4	0.691

s/v= 4.475 ms
 Evd= 32.6 MN/m²

Weather:

Project: Bell-S 2nd try

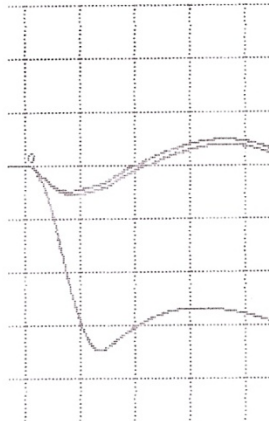
Plate base:

Testarea, -layer:

NRL-7232
 Institute, operator:

31 Jan 2009

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 2.0 mm/cm t: 10ms/cm
Card: #020507151116/11
Sa 31.01.09 13:05:08

Nr.	v (mm/s)	s (mm)
1.	877.2	6.992
2.	236.3	1.132
3.	246.6	1.012
i.M.	453.4	3.045

s/v= 6.716 ms
Evd= 7.4 MN/m²

Weather: *clouds*

Project:

Plate base:

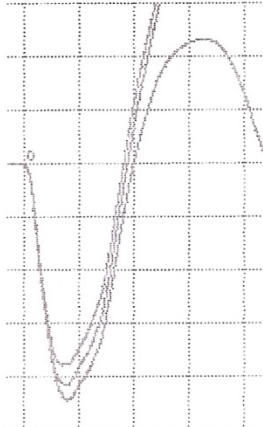
BELL T 1

Testarea, -layer:

NRL-7232

Institute, operator:

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 0.2 mm/cm t: 10ms/cm
Card: #020507151116/12
Sa 31.01.09 13:06:20

Nr.	v (mm/s)	s (mm)
1.	226.4	0.892
2.	231.2	0.833
3.	217.8	0.761
i.M.	225.1	0.829

s/v= 3.683 ms
Evd= 27.1 MN/m²

Weather: *clouds*

Project:

Plate base:

BELL T 2

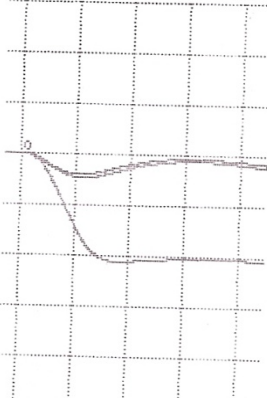
Testarea, -layer:

NRL-7232

Institute, operator:

31 Jan 2009

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 5.0 mm/cm t: 10ms/cm
Card: #020507151116/13
Sa 31.01.09 13:19:32

Nr.	v (mm/s)	s (mm)
1.	1113.3	10.666
2.	352.4	2.460
3.	324.1	2.091
i.M.	596.6	5.072

s/v = 8.502 ms
Evd = 4.4 MN/m²

Weather:

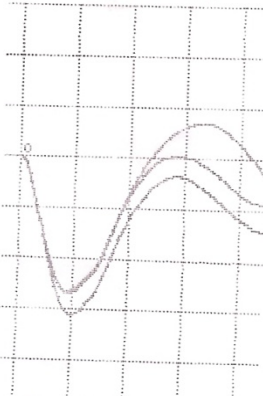
Project:

Plate base:

Roll U1
Testarea: -layer:

NRL-7232
Institute, operator:

DYN. PLATE LOADING TEST
LIGHT DROP-WEIGHT TESTER
TP BF-StB Teil B 8.3
Instrument: ZORN ZFG-2000
Device type: 300mm/10kg
Device number: #3876



s: 0.5 mm/cm t: 10ms/cm
Card: #020507151116/14
Sa 31.01.09 13:21:02

Nr.	v (mm/s)	s (mm)
1.	253.8	1.562
2.	248.9	1.354
3.	258.7	1.337
i.M.	253.8	1.418

s/v = 5.587 ms
Evd = 15.9 MN/m²

Weather:

Project:

Plate base:

Roll U2
Testarea: -layer:

NRL-7232
Institute, operator:

APPENDIX G

California Bearing Ratio (CBR)

1. Introduction

California Bearing Ratio (CBR) is used as an empirical measurement of shear strength, one of the two failure mechanisms of soil under load. Combat engineers from Marine Wing Support Squadrons determine soil strength or bearing capacity values for expeditionary airfields before the beginning of aircraft operations. At bases and stations physical scientists or specially trained civil engineer personnel may conduct these evaluations. In hostile situations, combat engineers attempt to conduct the evaluations under clandestine conditions. Basically, the engineers determine strength using a Dynamic Cone Penetrometer (DCP), and then correlate the DCP readings to a CBR value for use in supporting operations.

The DCP is the current USMC and USAF standard for measurement of bearing strength for airfields. The use of the DCP is described in ASTM D 6951-03 (American Society for Testing and Materials 2003). The dual-mass DCP consists of a 5/8-in.-diameter steel rod with a steel cone attached to one end, which is driven into the soil by means of a sliding dual-mass hammer. The angle of the cone is 60°, and the diameter of the base of the cone is 0.79 in. For HIHARES, the DCP is driven into the ground by dropping a 10.1-lb sliding hammer from a height of 22.6 in. The depth of cone penetration is measured at selected penetration or hammer-drop intervals and the soil shear strength is reported as the DCP index in millimeters/blow.

DCP test data are recorded in two columns, where the 1st column is number of blows and the 2nd column is cumulative penetration in mm. In accordance with Army Field Manuals, CBR is computed using the following empirical equations

$$\text{CBR} = 292 / \text{PR}^{1.12}$$

$$\text{CL soils: CBR} < 10: \text{CBR} = 1 / (0.017019 * \text{PR})^2$$

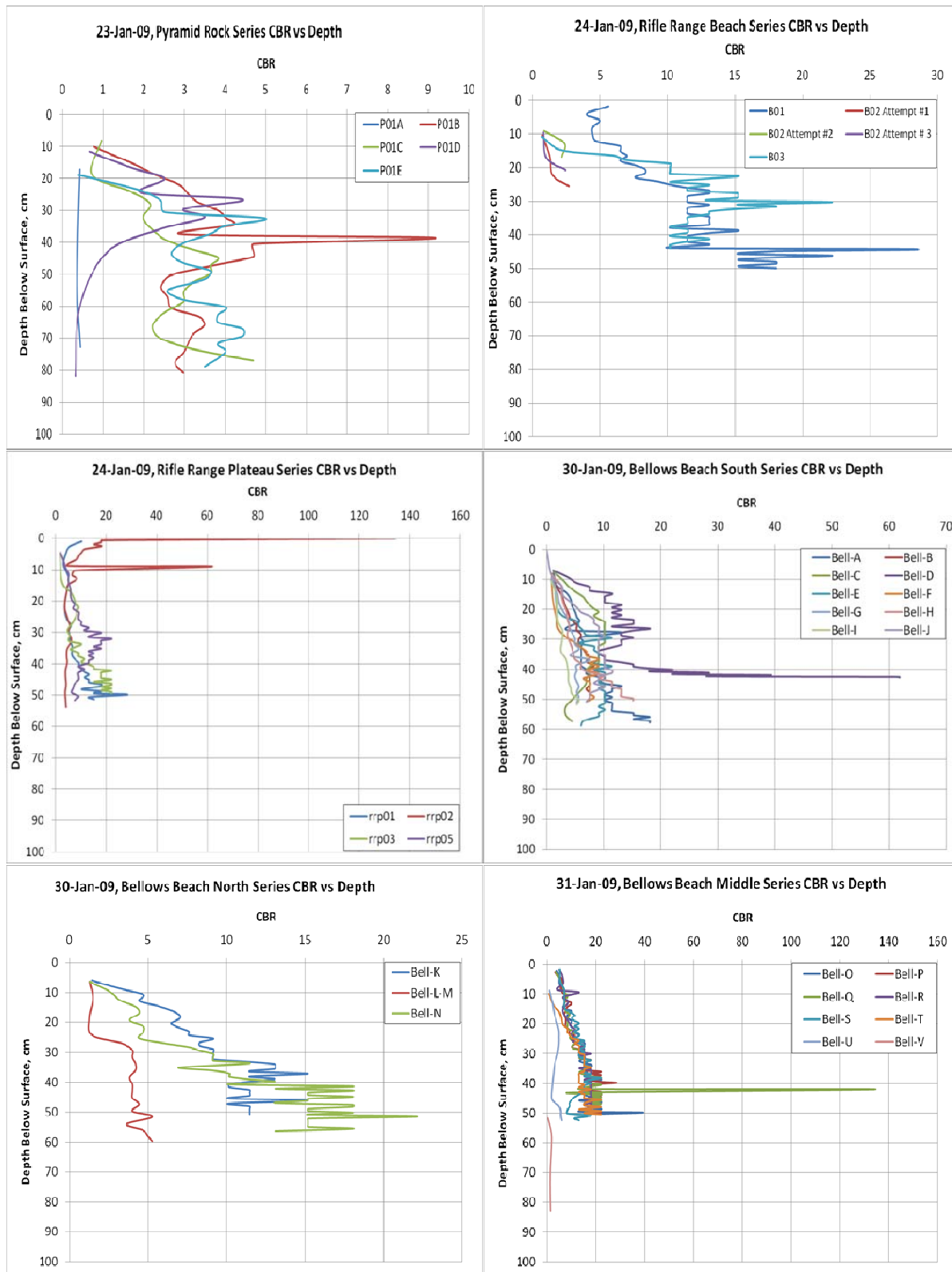
$$\text{CH soils: CBR} = 1 / (0.002871 * \text{PR})$$

where

- PR is the DCP penetration rate in mm per blow.
- CL soils are gravelly clays, sandy clays, silty clays, and lean clays.
- CH soils are inorganic clays of high plasticity, including fat clays, gumbo clays, volcanic clays, and bentonite.

HIHARES'09 demonstrates the utility of measuring CBR as a component of littoral penetration point classification and as a trafficability parameter. Graphs are shown which plot depth below surface (in cm) versus CBR. Please note that the CBR axis changes with each graph.

2. CBR vs Depth Graphs



APPENDIX H

Other Soil Properties

1. Introduction

Determining beach composition was an essential HIHARES'09 task involving the collection of "grab samples" across the beach. Two of four soils tests were accomplished, (1) moisture content determinations and (2) grading or sieve analysis. Future studies will include (3) basic properties tests, and (4) density standards and density determination tests. Sample locations were chosen that were representative of regions such as the beach face, foreshore, dune field, low marsh, high marsh, etc. If there was a major change in soil type, then the area was broken into sub-sites for sampling. Soil samples were collected with a corer to a critical depth of 6 inches. Samples are collected as quickly as possible and stored in either zip-loc bags or sediment corer tubes. This prevents the loss of moisture to evaporation. When possible, samples were placed in a cooler to keep the samples at a moderate temperature. Samples were then taken to the lab to determine soil moisture and grain size distributions.

2. Drying of Samples

After soil samples were taken to the lab, quick and careful procedures were taken to determine soil moisture. The moisture content is expressed as a percentage and is the mass of water divided by the dry mass of soil times one hundred. The following steps occurred:

1. We opened windows to ensure good ventilation owing to fumes from microwaving and baking.
2. The weighing container was weighed prior to putting soil on the container. This value will be needed for the calculation of soil moisture.
3. Approximately 25 grams of wet/moist soil was placed on the container and the weight of soil and container is measured.
4. Drying the sample is done with either a microwave oven or the field portable soil moisture oven. The microwave oven is faster for drying. The appropriate steps for drying with a microwave oven are as follows:
 - a. Place sample into microwave with a heat sink (brick) and run the microwave oven for 6 minutes.
 - b. Weigh the sample and return to microwave oven for 1 minute and reweigh. If the weight of the sample has changed, return to the microwave oven for 1 more minute.
 - c. Repeat the process until a constant weight is achieved.
 - d. Record the following measurements
 - $(\text{net weight}) - (\text{weight of container}) = \text{net soil weight}$
 - $(\text{dry weight}) - (\text{weight of container}) = \text{dry soil weight}$
 - $(\text{net soil weight}) - (\text{dry soil weight}) = \text{water weight}$
 - $(\text{water weight}) \div (\text{dry soil weight}) = \text{soil water content}$

(Typical drying times for a wet sample are less than 20 minutes. Water is the first component of the soil to heat and evaporate. If the sample is dry and microwave drying continues, the soil temperature will increase and oxidize organic matter. This will bias your results.)

3. Grain Size Distributions

After soil moisture is determined, samples are graded using a stack of appropriately sized sieves. For civil engineering applications, a certain series of sizes has come to be standard. Those most commonly used to grade materials have openings varying from 125 mm down to 0.075 mm and are stacked one on top of the other. (Tests are often described by identifying sieve sizes by their opening in millimeters followed by English aperture size: for example, 4.75 mm (No. 4) sieve. All sieves have square openings.) For beach composition, the grading analysis is the most important of all the soil tests, since factors such as beach gradient can be estimated from grain size. In order to grade the sample properly, the sieving operation uses a mechanical shaker to obtain lateral, vertical, and jarring actions, which keep the sample moving continuously over the surface of the sieve. After sufficient shaking, the mass of each sieve size shall be determined on a scale or balance. Then, the total percentage of material passing each sieve is calculated. Percentages shall be calculated to the nearest whole number except for the amount of material finer than the 0.075 mm (No. 200) sieve, which shall be reported to the nearest 0.1 percent. If the total amount of material finer than 0.075 mm (No. 200) sieve is desired, it is determined by adding the mass of material passing the 0.075 mm (No. 200) sieve by dry sieving.

Soil moisture and grain size data are provided below. In section 4, soil moisture and soil grain size distribution is displayed in tabular format. Section 5 displays graphs of soil grain size distribution.

4. HIHARES'09 Soil Moisture and Soil Grain Size Distribution Data

Date	Sample Name	Sample Depth (cm)	Total Tube Weight (g) Tube Wt=160g	Gallon Bag Weight (g)	Sub-Sample Wet Weight (g)	Sub-Sample Dry Weight (g)	H ₂ O (%)
1/23/2009	P01A	38.5cm	1175.17	1014.79	350.66	333.64	5.1013068
1/23/2009	P01B	42.0cm	1332.68	1179.88	344.15	326.1	5.53511193
1/23/2009	P01C	43.0cm	1371.08	1210.51	347.83	329.1	5.69127925
1/23/2009	P01D	25.6cm	860.26	700.95	342.17	323.51	5.76798244
1/23/2009	P01E	32.0cm	1017.91	860.23	322.78	298.5	8.13400335
Rifle Range Beach 24-Jan-2009							
1/24/2009	RRB01	13.5cm	617.06	457.5	457.5	387.31	18.1224342
1/24/2009	RRB02	22.5cm	1052.92	890.79	325.6	313.48	3.86627536
1/24/2009	RRB03	21.0cm	948.84	790.07	362.7	355.35	2.06838328
1/24/2009	RRB01(3")	3"			345.38	300.99	14.7479983
1/24/2009	RRB02(3")	3"			621.42	593.55	4.69547637
1/24/2009	RRB03(3")	3"			394.21	386.67	1.94998319
Rifle Range Plateau 24-Jan-2009							
1/24/2009	RRP01	35.0 cm	1246.53	1088.05	314.6	278.45	12.9825822
1/24/2009	RRP02	38.5 cm	1361.28	1203.16	334.48	312.28	7.10900474
1/24/2009	RRP03	32.8 cm	1325.01	1166.55	331.74	314.29	5.55219702
1/24/2009	RRP05	24.0 cm	715.84	558.24	326.43	264.5	23.4139887
1/24/2009	RRP01(3")	3"		654.31	387.01	327.15	18.2974171
1/24/2009	RRP02(3")	3"		1040.94	347.11	320.4	8.33645443
1/24/2009	RRP03(3")	3"		1014.06	350.65	334.07	4.9630317
1/24/2009	RRP05(3")	3"		538.95	353.49	288.14	22.6799472

Date	Sample Name	Sample Deep (cm)	600um wt(g)	425um wt(g)	300um wt(g)	150um wt(g)	106um wt(g)	90um wt(g)	75um wt(g)	63um wt(g)	45um wt(g)	27um wt(g)	< 27um wt(g)
1/23/2009	P01A	38.5cm	0	34.25	96.16	201.22	1.4	0.2	0	0	0	0	0
1/23/2009	P01B	42.0cm	9.3	44.15	114.13	157	0.98	0.2	0	0	0	0	0
1/23/2009	P01C	43.0cm	21	66.58	120	120.23	0.92	0	0	0	0	0	0
1/23/2009	P01D	25.6cm	11.8	53.5	112.5	145	1.55	0	0	0	0	0	0
1/23/2009	P01E	32.0cm	11.3	48	113.4	125	0.76	0	0	0	0	0	0
Rifle Range Beach 24-Jan-2009													
1/24/2009	RRB01	13.5cm	11.94	28.81	223.86	88.66	7.24	3	3.25	2.6	5.31	8.76	3.75
1/24/2009	RRB02	22.5cm	6.8	71.84	202.61	31.74	0.06	0	0	0	0	0	0
1/24/2009	RRB03	21.0cm	2.19	50.43	252	50.3	0.05	0	0	0	0	0	0
1/24/2009	RRB01(3")	3"	20.73	14.66	173.61	82.73	2.87	1.12	1.18	0.87	1.71	1.91	1.06
1/24/2009	RRB02(3")	3"	6.5	91.88	413.61	81.06	0.28	0	0	0	0	0	0
1/24/2009	RRB03(3")	3"	6.4	55.23	45.04	0.74	0.31	0.26	0.25	0.42	0.56	0	0
Rifle Range Plateau 24-Jan-2009													
1/24/2009	RRP01	35.0 cm	31.58	73.57	66.11	84.51	11.44	3.46	2.81	1.74	2.56	1.74	0.56
1/24/2009	RRP02	38.5 cm	98.63	134.43	45.3	29.53	2.04	0.65	0.64	0.43	0.65	0.92	0.1
1/24/2009	RRP03	32.8 cm	56.45	126.54	73.34	53.78	2.57	0.67	0.52	0.37	0.5	0.57	0.32
1/24/2009	RRP05	24.0 cm	33.71	36.89	33.11	72.22	31.56	13.4	12.09	7.55	12.52	10.01	4.42
1/24/2009	RRP01(3")	3"	15.93	34.73	37.08	102.11	42.95	20.29	16.45	11.33	17.69	18.02	7.67
1/24/2009	RRP02(3")	3"	106.5	151.94	29.19	22.44	3.74	1.31	1.24	0.9	1.55	2.36	1.49
1/24/2009	RRP03(3")	3"	137.85	130.33	29.76	28.73	2.77	1.45	1.13	0.79	0.89	1.01	0
1/24/2009	RRP05(3")	3"											

Date	Sample Name	600um (%)	425um (%)	300um (%)	150um (%)	106um (%)	90um (%)	75um (%)	63um (%)	45um (%)	27um (%)	pan (%)
1/23/2009	P01A	0	10.26556	28.82148	60.3105143	0.419614	0.059945	0	0	0	0	0
1/23/2009	P01B	2.851886	13.53879	34.99847	48.1447409	0.300521	0.061331	0	0	0	0	0
1/23/2009	P01C	6.381039	20.23093	36.46308	36.5329687	0.27955	0	0	0	0	0	0
1/23/2009	P01D	3.647492	16.53736	34.77481	44.8208711	0.47912	0	0	0	0	0	0
1/23/2009	P01E	3.785595	16.0804	37.98995	41.8760469	0.254606	0	0	0	0	0	0
Riffle Range Beach 24-Jan-2009												
1/24/2009	RRB01	3.082802	7.438486	57.79866	22.8912241	1.869304	0.774573	0.839121	0.671297	1.370995	2.261754	0.968217
1/24/2009	RRB02	2.169197	22.91693	64.63251	10.1250478	0.01914	0	0	0	0	0	0
1/24/2009	RRB03	0.616294	14.19164	70.916	14.1550584	0.014071	0	0	0	0	0	0
1/24/2009	RRB01(3")	6.887272	4.870594	57.67966	27.485963	0.95352	0.372105	0.39204	0.289046	0.568125	0.634573	0.352171
1/24/2009	RRB02(3")	1.095106	15.47974	69.6841	13.6568107	0.047174	0	0	0	0	0	0
1/24/2009	RRB03(3")	1.655158	14.2835	11.64818	0.19137766	0.080172	0.067241	0.064655	0.10862	0.144826	0	0
Riffle Range Plateau 24-Jan-2009												
1/24/2009	RRP01	11.34135	26.42126	23.74214	30.3501526	4.108458	1.242593	1.009158	0.624888	0.919375	0.624888	0.201113
1/24/2009	RRP02	31.58384	43.04791	14.50621	9.45625721	0.65326	0.208147	0.204944	0.137697	0.208147	0.294607	0.032023
1/24/2009	RRP03	17.96112	40.26218	23.33514	17.1115848	0.817716	0.213179	0.165452	0.117726	0.159089	0.181361	0.101817
1/24/2009	RRP05	12.7448	13.94707	12.51796	27.3043478	11.93195	5.066163	4.570888	2.854442	4.733459	3.784499	1.671078
1/24/2009	RRP01(3")	4.869326	10.61593	11.33425	31.2119823	13.12853	6.202048	5.028274	3.463243	5.407306	5.508177	2.34449
1/24/2009	RRP02(3")	33.2397	47.42197	9.110487	7.00374532	1.167291	0.408864	0.387016	0.280899	0.48377	0.736579	0.465044
1/24/2009	RRP03(3")	41.26381	39.01278	8.908313	8.59999401	0.829168	0.434041	0.338252	0.236477	0.266411	0.302332	0

5. Soil Grain Size Distribution Graphs

